Renewables

KW6
Installation Manual

Kingspan®
WIND

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NB: This manual shows the installation process using a 15m flange bolted monopole tower. For installation on a different height flange bolted monopole or any other Kingspan approved tower please read this manual in conjunction with the specific tower Installation manual. Disclaimer: The information in this manual is believed to be correct and reliable. However Kingspan assumes no responsibility for any inaccuracies and/or omissions. The user of this manual and the wind turbine including all its subsystems assumes full responsibility and risk. All specifications are subject to change without notice. Incorrectly installed, operated or maintained wind turbines systems are capable of causing serious injury or fire. Installation, service and any maintenance work should only be undertaken by a Kingspan certified wind turbine installer.

1. Introduction

1.1 System Description

The KW6 is a downwind three bladed wind turbine. It comprises a steel wind turbine frame mounted on a steel tower assembly. The wind turbine frame supports encapsulated windings and bearings that in turn support a rotating shaft and permanent magnet rotor assembly. One end of the shaft has a propeller blade assembly comprising three glass polypropylene blades that are hinged on a rotor plate. The blades are held in their correct position by Zebedee springs that allow the blades to form a cone shape in high winds. In this shape, the wind turbine is able to limit its speed byreducing the swept area and changing the blade pitch angle towards stall. The wind turbine frame also houses a service brake assembly that acts upon a brake attached to the rotor shaft.

The tower that is connected to the wind turbine frame has a steel base plate that incorporates a raising and lowering mechanism. The top of the tower has a yaw bearing assembly that permits the wind turbine frame to rotate. The blades are therefore able to turn depending on wind direction and speed. A winch mounted inside the tower is connected to the service brake in the wind turbine frame.

The generator encapsulated stator windings are connected to a slip ring unit at the top of the tower for onwards connection to a certified junction box.

1.2 System Components

The main system components for the KW6 wind turbine are:

- Wind turbine frame and generator
- Glass polypropylene blades
- Slip ring unit
- Wind turbine tower
- Brake assembly

Contained within the hollow tower section are the following components:

- Wind turbine brake rope – 3mm diameter stainless steel wire rope
- Brake winch
- Power cable - Between slip-ring unit at the tower top and the junction box at the bottom: 1 x 3 core 10sq mm cable

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1.3 System Specifications

Rotor
Type: Downwind, 360 degrees free yawing
Speed control: Self-regulating
Blades: 3 blades, passive coning and pitch control
Rotor diameter: 5.5m
Rated speed: 200 rpm @ 12m/s
Rotor trust: 10kN

Generator
Type: Brushless permanent magnet, direct drive
Output: Grid connect, battery charging 24/48V, direct heating 240V switch DC

Towers
Type: Self-supporting hinged monopole
Hub height: 9m or 15m

Pad foundations (root options also available)
3.80m x 3.80m x 1.00m (15m tower)
3.05m x 3.05m x 1.00m (9m tower)

Weight
Wind turbine head: 600kg

Noise label
Ongoing testing - acoustic noise levels not yet available

Performance
Cut-in wind speed: 2.5m/s
Max wind speed (survival): 70m/s
Estimated annual output: 6,000 – 12,000kWh

Build materials and colours
Frame: Galvanised steel, grey (not visible)
Blades: Glass thermoplastic composite, black or white
Covers: Plastic, black or white
Towers: Galvanised steel, grey

1.4 Health And Safety Information

Please refer installation and servicing to qualified personnel only. High currents are produced by this wind turbine system and incorrect installation or use may result in risk of electric shock, fire or mechanical damage.

Warning!

Installation of the wind turbine involves handling heavy components such as the wind turbine nacelle, blades and covers. Appropriate work wear (e.g. gloves, helmets, safety footwear and eye protection) appropriate lifting gear, techniques and appropriate number of personnel should be used at all times.

Personal Precautions
Kingspan recommend a two person team as a minimum for mechanical installation of a Kingspan wind turbine – they should use standard protective clothing. Use only certified lifting straps and strops.

Weather
The wind turbine should be installed in periods of wind speeds less than 12 m/s (25 mph or 43 km/h) and generally calm weather conditions.

2.0 Electrical Installation

The KW6 wind turbine is specially designed for connection to low voltage (LV) network at 230Vac 50Hz nominal by means of SMA Windy Boy grid connect inverter.

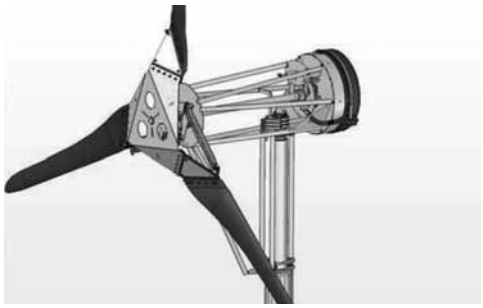
It is suitable for domestic, agricultural and SME applications. It is estimated that it will produce 6,000 - 12,000 kWh per annum depending on the wind resource available.

2.1 Schematic For Connection

Please refer to the electrical schematics. The main elements are:

- KW6 wind turbine containing a 3-phase AC synchronous variable speed alternator.
- Kingspan Wind grid connect inverter and controller package comprising
  - DC disconnect - allowing the wind turbine to be isolated from the grid connect inverters
  - Controller which displays wind turbine voltage and current, rectifies AC input from the wind turbine and outputs DC power for the grid connect inverter
  - SMA Windy Boy grid connect inverter of the self commutating static type
- AC disconnect lockable - allowing the grid to be securely isolated from the inverter

The output from the AC lockable disconnect is normally connected to a spare fuse or breaker at the customer distribution board rated at >32A.



2.2 Generator

The KW6 contains a purpose built permanent magnet generator which is directly driven by the rotor at variable speed according to wind conditions.

2.2.1 Type of Generator

The generator is a permanent magnet synchronous 3-phase AC alternator suitable for variable speed operation.

2.2.2 Selected Operating Characteristics

The output voltage open circuit is proportional to RPM of the wind turbine. The output voltage during normal operation is dependent on the load placed on the generator.

The output of the generator is connected to the control box which contains a 3-phase rectifier.

There are no touching parts or brushes in the generator and it is maintenance free. Generator has 12 poles and a nominal AC frequency of 20Hz@200rpm.

	Minimum speed	Typical speed (during operation)	Maximum speed
RPM	0	100 - 200	200
Approx wind speed	0 - 5mph	5 – 25mph	> 25mph (blades cone at higher wind speeds to maintain this max shaft rpm)
Generator output voltage Vac under normal operating conditions Vop AC	0	200 – 225Vac 3-ph	225Vac 3-ph
Generator output voltage Vac if grid fault (inverter disconnected from grid) Voc AC	0	400 – 450Vac 3-ph	450Vac 3-ph
Input DC voltage to grid connect inverter under normal operating conditions Vop DC	0	240 – 300V DC	300V DC
Input DC voltage to grid connect inverter if grid fault (inverter disconnected from grid) Voc DC	0	480 – 540V DC	540V DC

The generator can be disconnected at any load without any problems. In this case the winding voltage rises and the wind turbine will speed up slightly until the blades mechanically govern to the maximum rpm. On reconnection of load the wind turbine winding voltage will fall gradually to normal operating value due to the intelligent switch-on strategy of the inverter used (after the switch-on delay period has passed).

2.3 Control Box

Control box has the following functions:

- Converts output 3-phase AC variable voltage of the wind turbine to DC variable voltage for input to the grid connect inverter
- Isolation point of the wind turbine
- Displays voltage and current from the wind turbine (V&I)
- Protects inverter from overvoltage using two protection methods. The first method is to introduce a voltage dropping resistor between the wind turbine and the inverter. The second method is to disconnect the wind turbine from the inverter

2.4 Grid Connect Inverter

The SMA Windy Boy inverter has the following functions:

- Conversion of variable voltage DC input to synchronised 230Vac 50Hz nominal
- 180ms delay after grid fault until re-connect to grid
- Trip out on over/under voltage
- Trip out on over/under frequency
- Disconnection on loss of mains

2.4.1 Description Of Typical System Commissioning Procedure

At the start of a typical commissioning procedure the following should be the situation:

- The wind turbine is mechanically braked
- The wind turbine is isolated from the grid connect inverter
- The grid connect inverter is isolated from the grid

The typical start up sequence is:

- Connect the 3-phase AC supply from wind turbine to the inverter by switching on the 3-pole disconnect in the controller box.
- Release the wind turbine mechanical brake. The wind turbine starts to rotate if wind conditions are more than about 5mph. The inverter waits until input DC voltage is >250V before starting its self test and safety procedures at which point the ORANGE LED on the front of the inverter will flash approx once per second.
- Connect the inverter to grid AC by turning the lockable AC disconnect to the ON position. At this point the inverter starts monitoring grid AC voltage, frequency and impedance. After a few seconds the GREEN LED starts to flash. First the inverter checks voltage and frequency are within allowed ranges and that grid impedance is <1.25Ω. If all is OK then it waits 180 seconds (required by G83/1 and G59) and then starts its "connect to AC network" procedure. After completion of this procedure (will take approx 5 minutes depending on wind conditions the GREEN LED will stay on continuously.
- If the inverter input DC voltage is <180VDC for >300 seconds then there is not enough wind power available and the inverter shuts down and goes into sleep mode (All LEDs off). Higher input DC voltages will wake it up when wind speeds increase and it will then repeat this connection procedure.

2.5 Description of Typical System Operation

A typical operating strategy during a windy period is summarised by:

- Continuous and automatic monitoring of Vac and fac by the inverter
- Inverter will disconnect from grid network in < 0.5s should Vac or fac go out of their allowed ranges under the connection settings
- Inverter continuously adjusts output AC amps to match the wind energy available.

A typical operating strategy during a calm period is summarised by:

- Inverter goes into sleep mode after disconnecting from grid network.
- If wind increases then the inverter will start up as described in the commissioning section 2.4.1.

A typical operating strategy during a loss of mains is summarised by:

- Inverter disconnects from grid network in < 0.2s and monitors Vac and fac continuously. At this point the wind turbine will speed up
- Should Vac and fac return to allowed ranges then the inverter will start up as described in the commissioning section 2.4.1.

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2.6 Inverter Disconnection from Grid

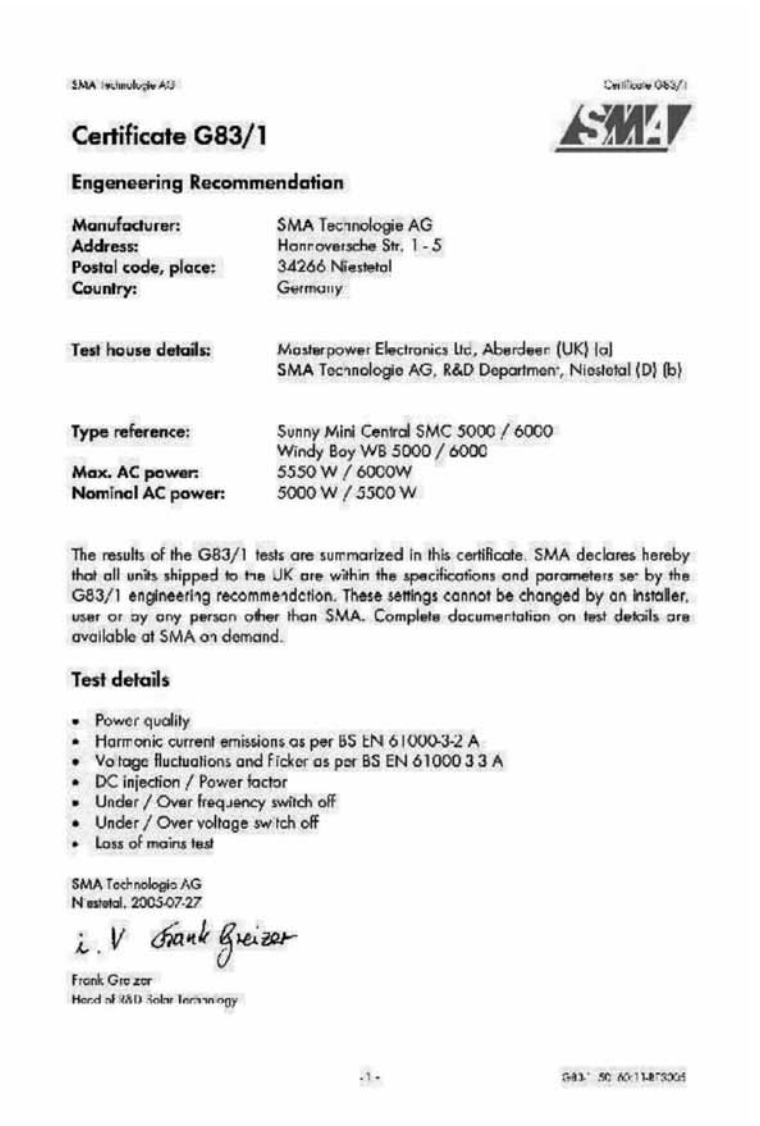
Windy Boy inverters contain an independent disconnection device SMA grid guard 2 (all-pole isolation on grid side) and are type tested to be suitable for use under G83/1 regulations.

- Excerpt from a Windy Boy manual: "The Windy Boy is equipped with the SMA Grid Guard 2. This is a type of automatic disconnection device. It ensures that the Windy Boy complies with the new VDEW (Verband der Elekrizitatswirtschaft – German Electricity Industry Association) regulations for the operation of power-generating systems in parallel to the low-voltage grid of the electricity supply company and with DIN VDE 0126-1-1, which forms a part of these regulations.

2.7 Electrical Wiring and Installation

Kingspan recommend that electrical wiring and installation are carried in accordance with the Energy Saving Trust publication CE72 "Installing small wind-powered electricity generating systems" and BS7671 "IEE Wiring Regulations for Electrical Installations".

The schematics drawings provided in appendix A have been provided to assist in wiring components to the above mentioned standards



SMA Technologie AG

Certificate G83/1

Certificate G83/1

Engeneering Recommendation

Manufacturer:	SMA Technologie AG
Address:	Hannoversche Str. 1 - 5
Postal code, place:	34266 Niestetal
Country:	Germany
Test house details:	Masterpower Electronics Ltd., Aberdeen (UK) (a) SMA Technologie AG, R&D Department, Niestetal (D) (b)
Type reference:	Sunny Mini Central SMC 5000 / 6000 Windy Boy WB 5000 / 6000
Max. AC power:	5550 W / 6000W
Nominal AC power:	5000 W / 5500 W

The results of the G83/1 tests are summarized in this certificate. SMA declares hereby that all units shipped to the UK are within the specifications and parameters set by the G83/1 engineering recommendation. These settings cannot be changed by an installer, user or by any person other than SMA. Complete documentation on test details are available at SMA on demand.

Test details

- Power quality
- Harmonic current emissions as per BS EN 61000-3-2 A
- Voltage fluctuations and Flicker as per BS EN 61000 3 3 A
- DC injection / Power factor
- Under / Over frequency switch off
- Under / Over voltage switch off
- Loss of mains test

SMA Technologie AG
Niestetal, 2005-07-27

i. V Frank Greizer

Frank Greizer
Head of R&D Solar Technology

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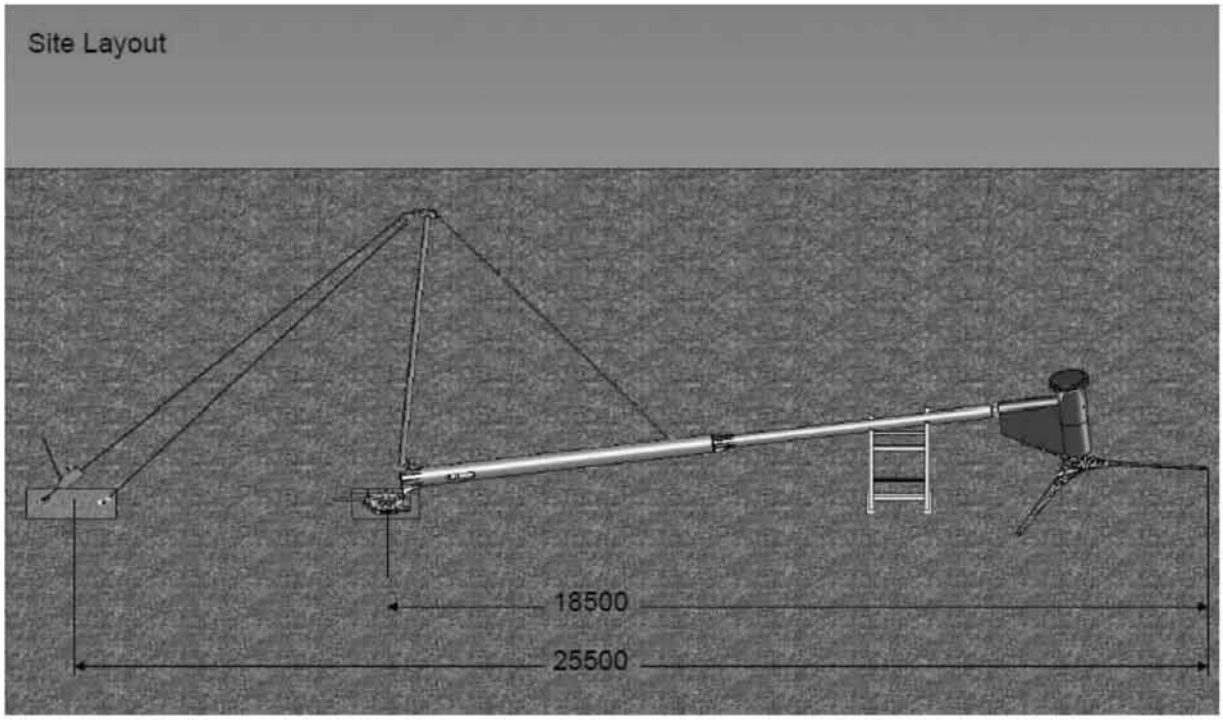
G83/1-SC-0511MP5005

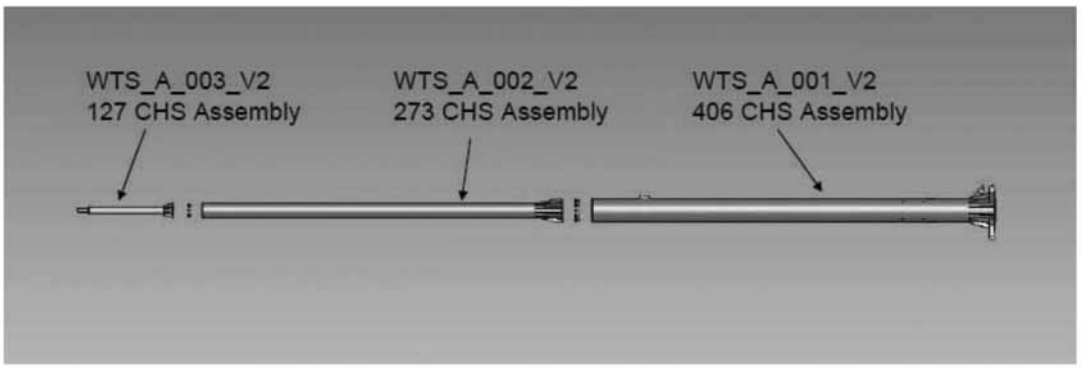
3.0 Mechanical Installation

Qty	Description	Used For
2	10mm spanners (one open ended)	Slip ring
2	13mm spanners (one open ended)	Blade and spring fixings
2	17mm spanners (one open ended)	Blade fixing bolts, spring U-bracket fixings
2	19mm spanners (one open ended)	Yaw rollers
2	24mm spanners (one open ended)	Yaw bearing, main shaft bearing at generator end (normally factory tightened)
1	Socket set (10mm to 32mm)	Wind turbine head assembly
1	7mm socket including ratchet	Fastening bulldog clips on brake cable
1	3mm allen key	Slip ring grub screw
1	Pair of wire snips	Trimming cover cable ties
1	5mm allen key	Yaw bearing grub screw
1	46mm and 55mm sockets	Tower bolts
1	Torque wrench (up to 330Nm)	Frame assembly
1	Torque wrench and/or multiplier (up to 1360Nm)	Fastening tower/base bolts
1	Podger (optional)	Assists in frame assembly
1	Tube of glazing silicon and gun	Cover sealant
1	Loctite 577 or equal product	All fixings - MUST BE USED WITH ALL STAINLESS STEEL NUTS AND BOLTS
1 set	Pliers, wire strippers, crimping tool, assorted crimp lugs etc.	Wiring
1	Hacksaw	Removing locked stainless steel nuts (this can sometimes happen)
1	Battery grinder (optional)	Removing locked stainless steel nuts - trimming covers if required
1	Flat, round and square file set	Removing any galvanising build up
1	Screw driver set	Slip ring brushes
1	Battery drill and nut driver	Blade fixings
1	Flat file	Removing any galvanising drips to allow tower fitting with yaw bearing
1	12T hydraulic jack	For controller raising and initial tilt of wind turbine during lowering
1 set	3.2t Tirfor winch, 30m tirfor wire rope (16mm dia) 3t pulley block 3t shackle 3T shackle or short strop Trestle to support the tower when it is in lowered position	For raising and lowering the wind turbine on 15m flange bolted monopole tower. Check requirements if you are using any other tower.

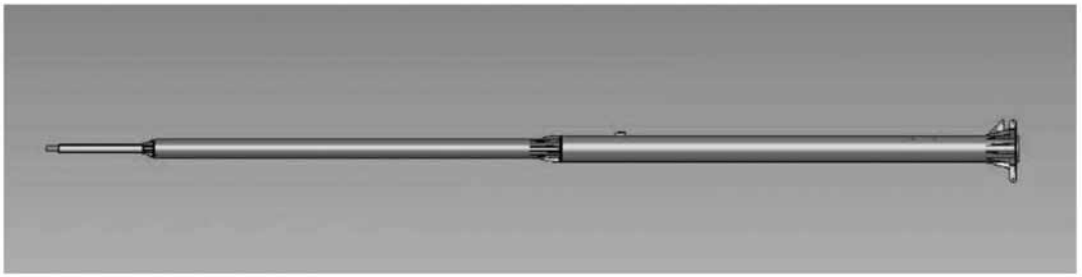
3.2 Tower Assembly (Procedure Provided by Hutchinson Engineering)

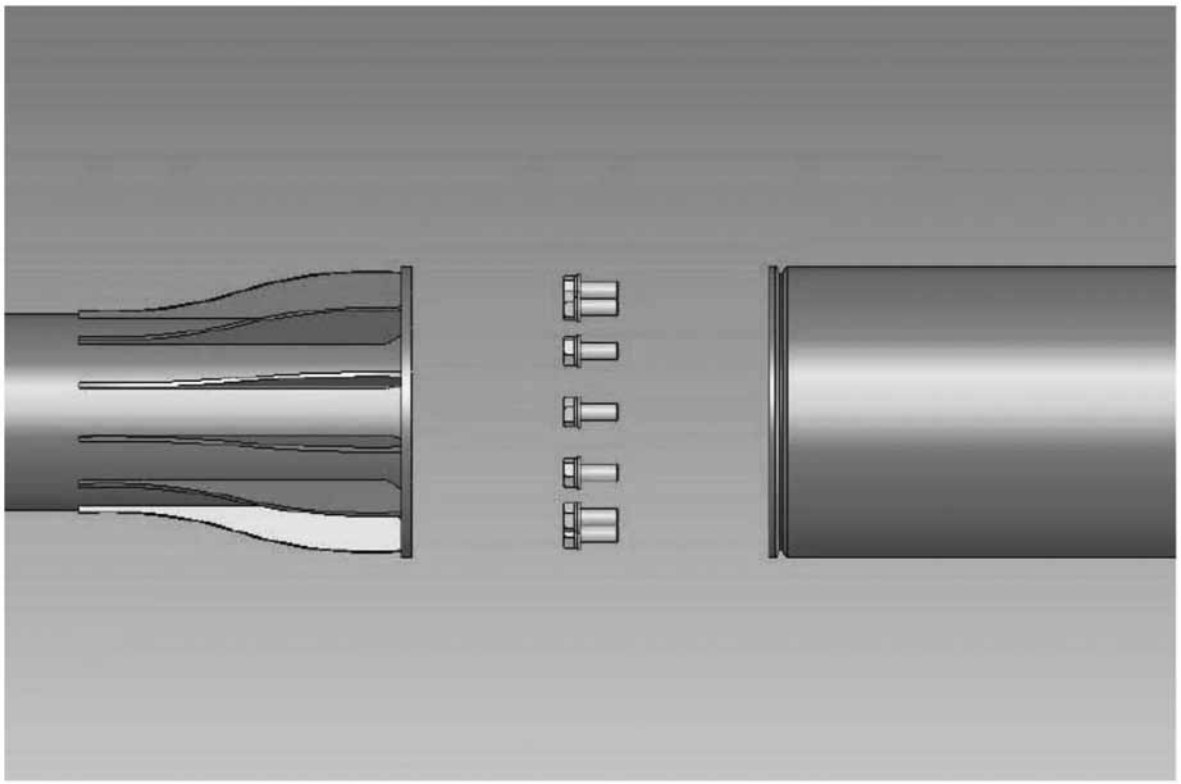


Site layout : Note that with the pole folded down, the overall Length from tip of blade to root centre is 18.5m. The 2m x 1.5m x 1m anchor pad must also be installed 7m from root centre to centre. This is critical to measure out before installing the pole on site.



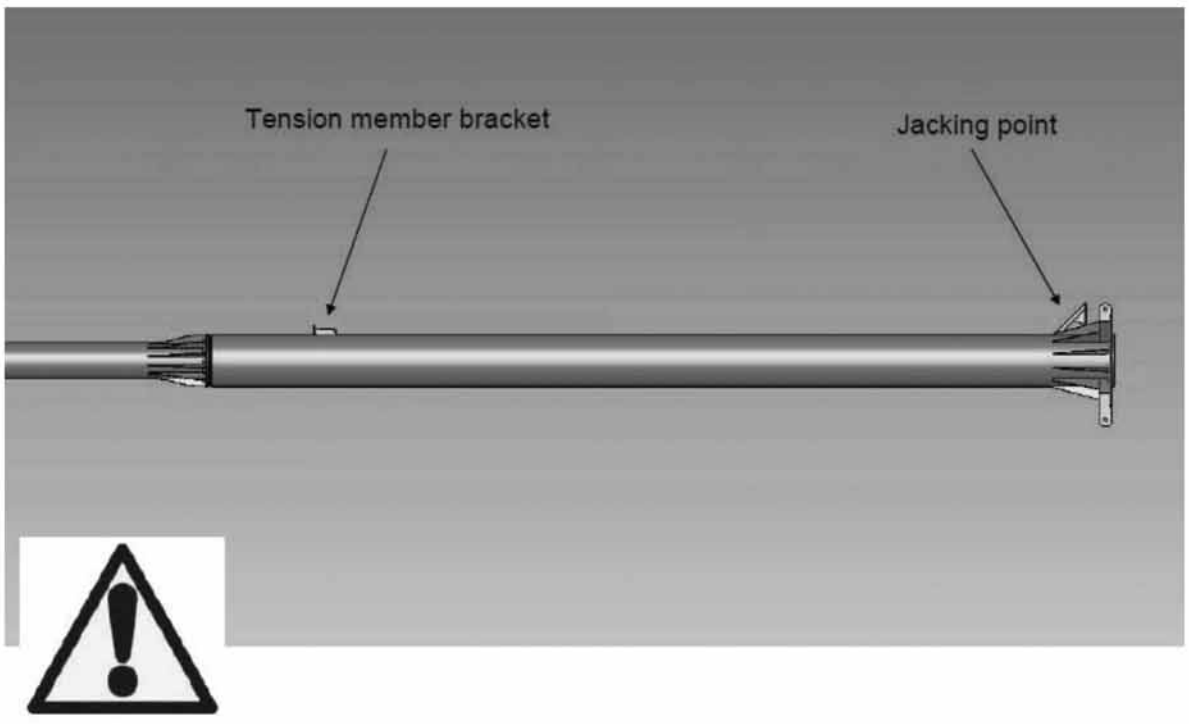
Assembled pole structure



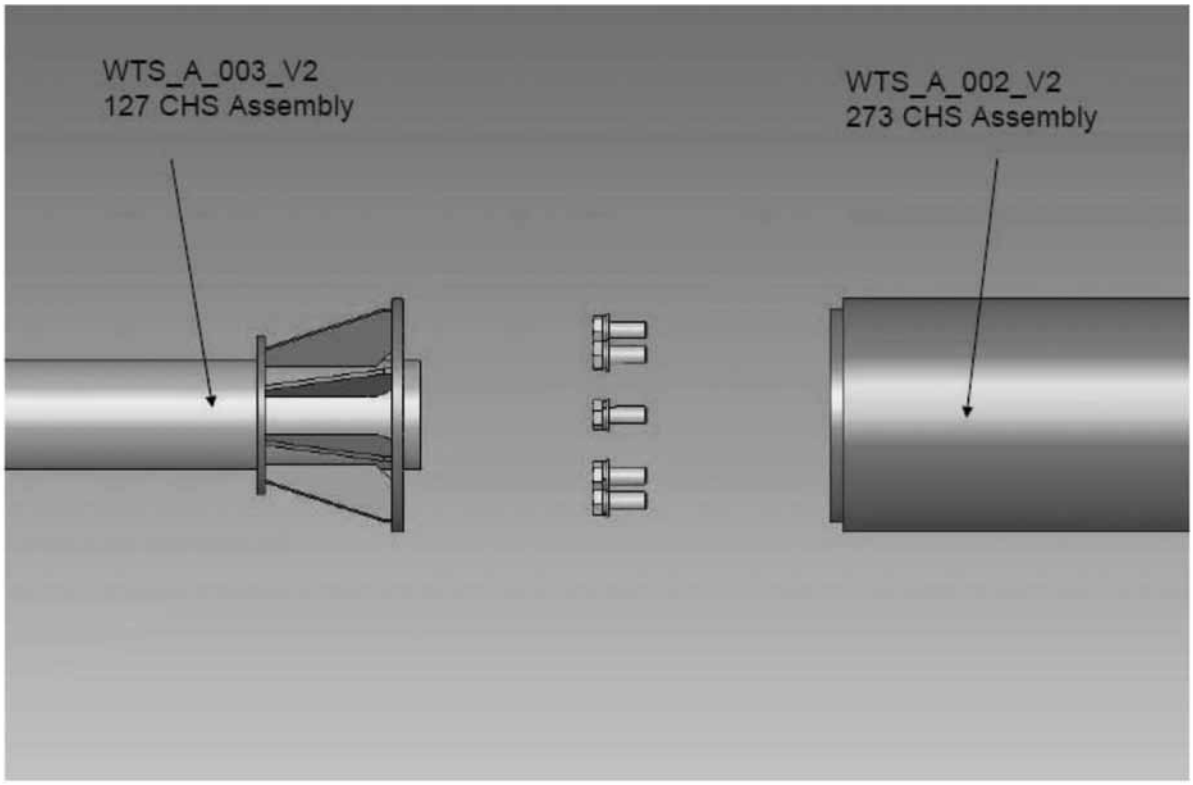


Assemble 273 CHS assembly to 406 CHS assembly using M24x60 bolts, plain washers and spring washers (12 off each). Ensure poles are straight when bolted together.

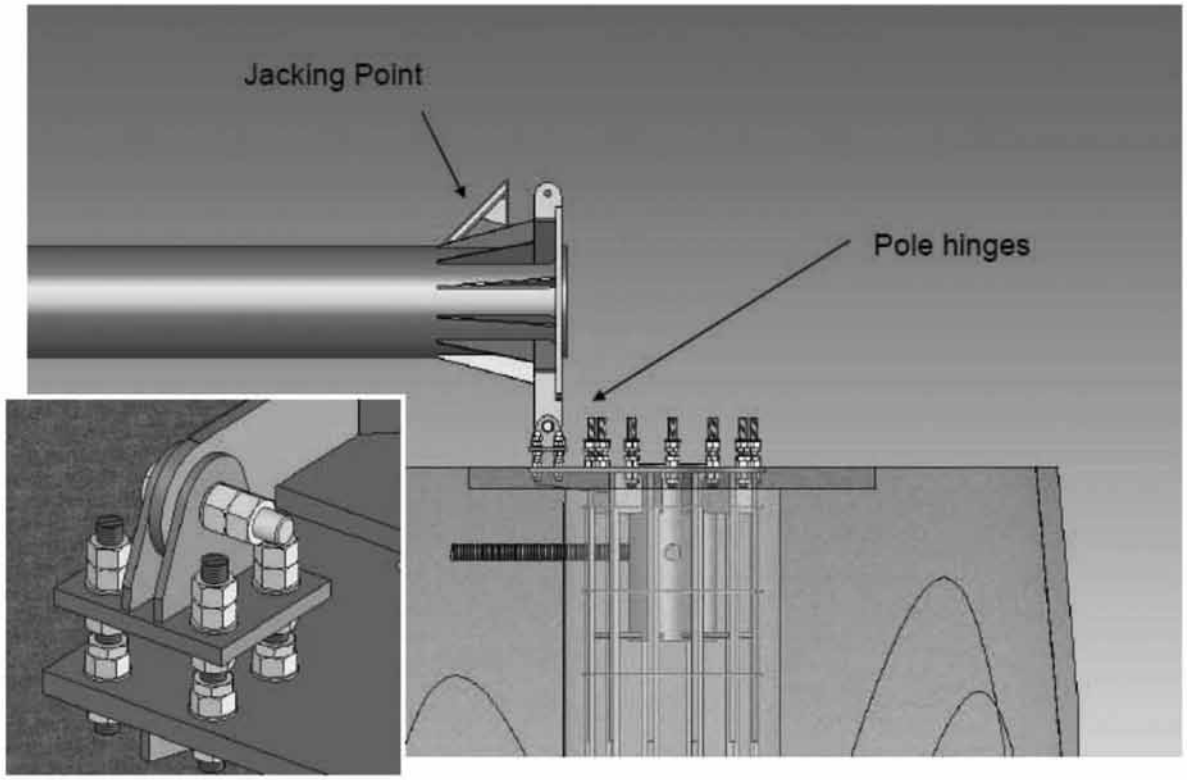
See page 33 for tower bolt torque settings



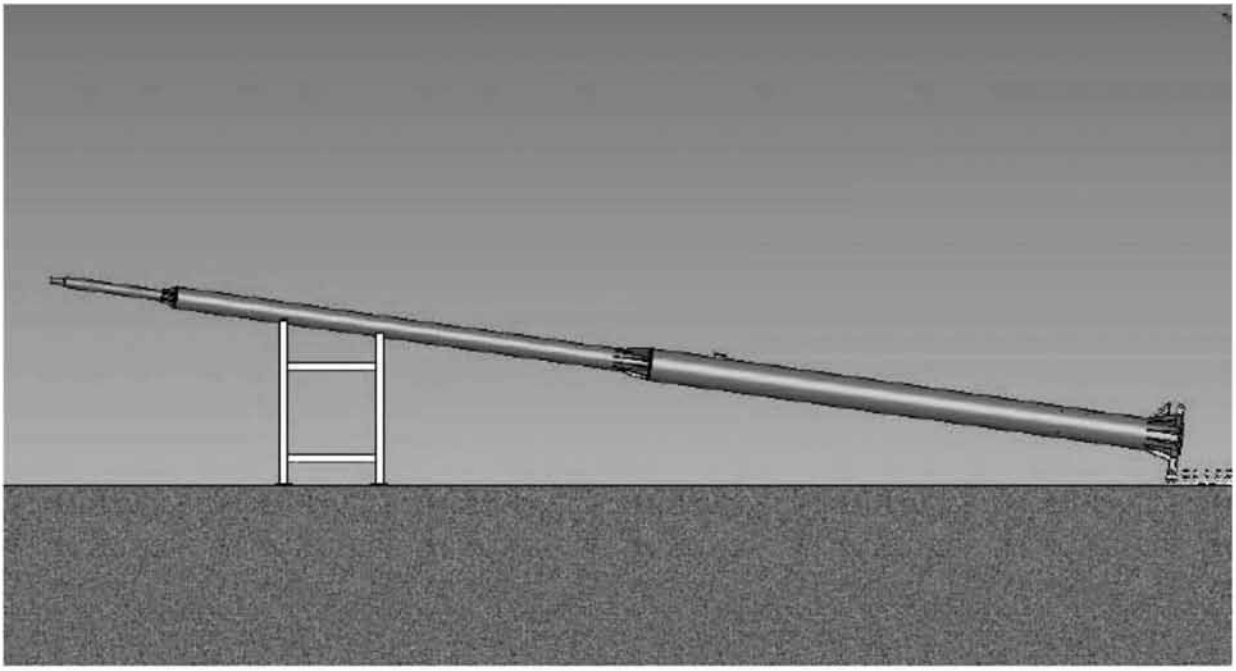
Ensure the 273 CHS section is square to the 406 CHS assembly when bolted together.



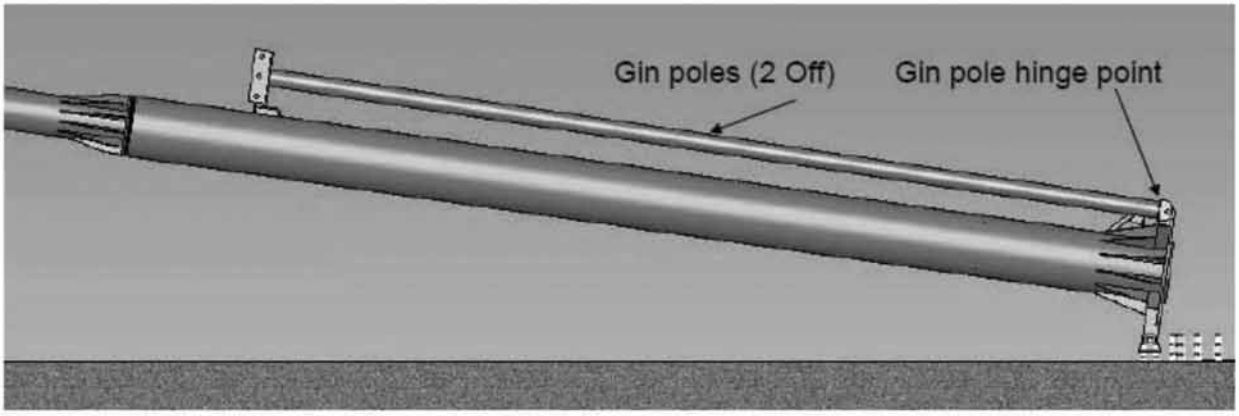
Assemble 127 CHS assembly to 273 CHS assembly using M20x50 bolts, plain washers and spring washers (8 off each). Ensure poles are straight when bolted together



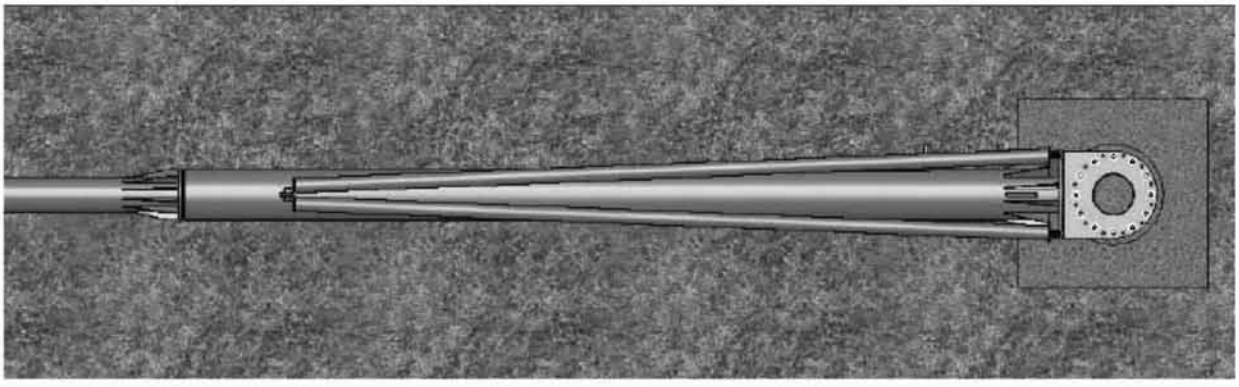
Install the assembled pole onto the hinge brackets via mechanical means. Secure with M24x110 bolt (x1) plain washers (x2) and M24 nuts (x2) per hinge. Ensure the pole is installed in the correct orientation, with the jacking point facing upwards.

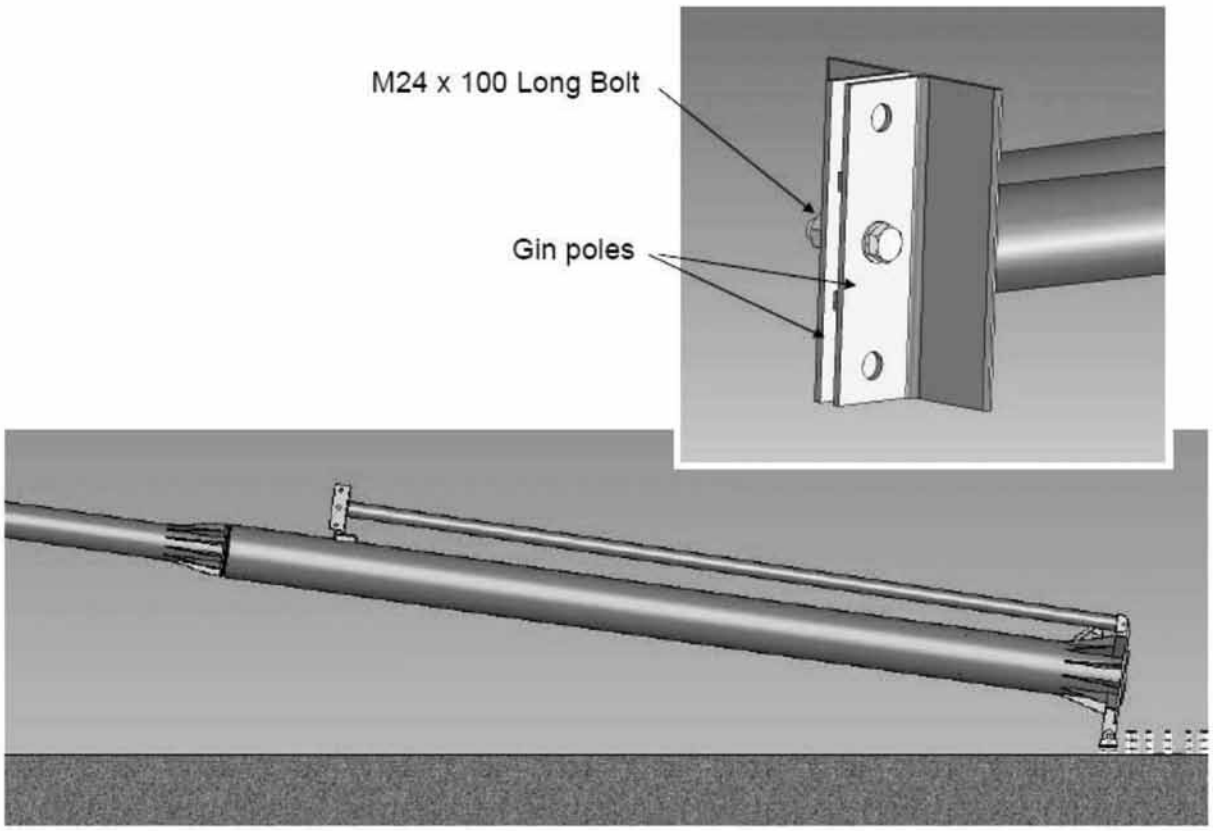


Using mechanical means the pole structure should now be positioned on a suitable trestle just over 3m from the end of the pole, with sufficient height to allow installation of the turbine head.

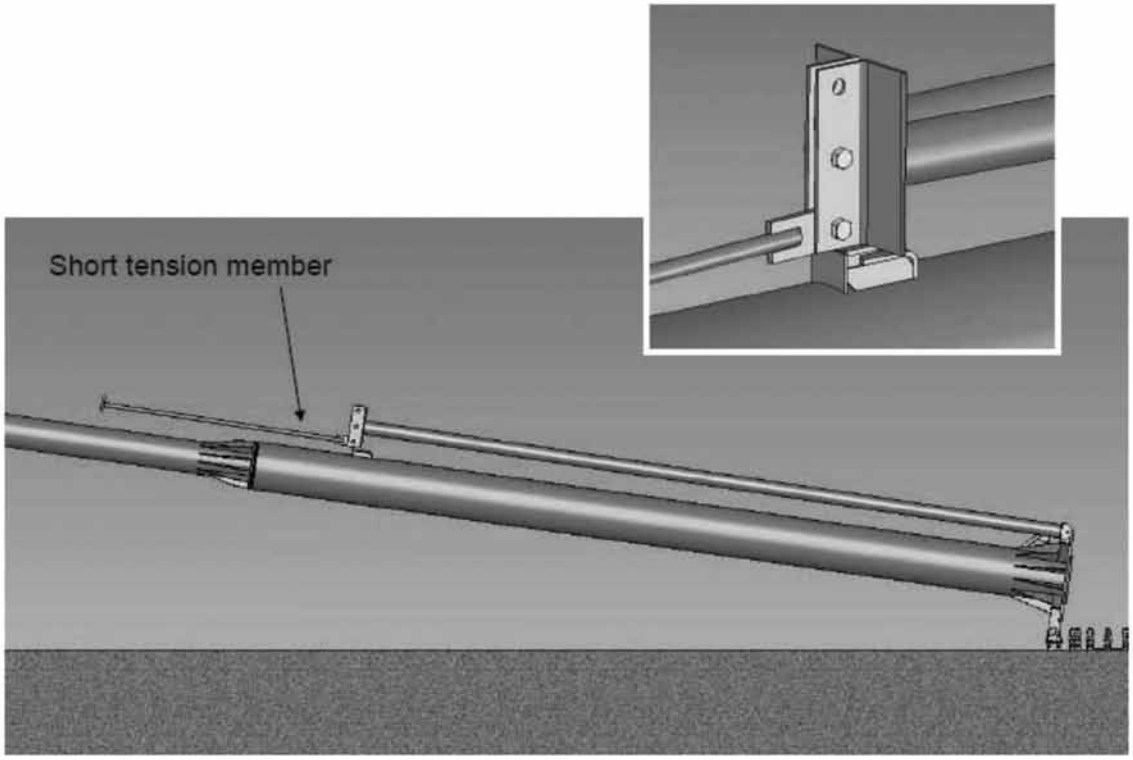


Install the gin poles in the orientation shown above. Both poles are fitted to the hinge point at the base plate using 1x M20x100 Bolt, 2 x plain washers and 2x M20 nuts per gin pole. The ends of the gin poles will meet in the middle, as shown below

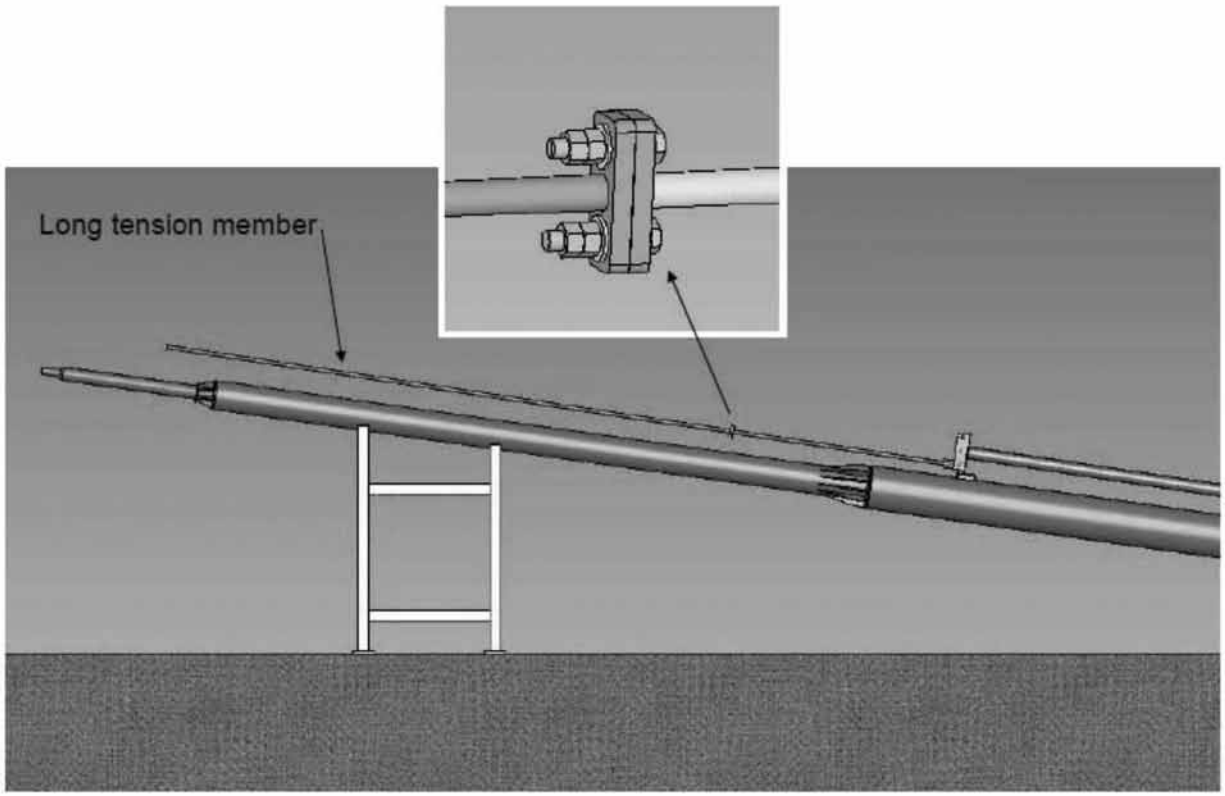




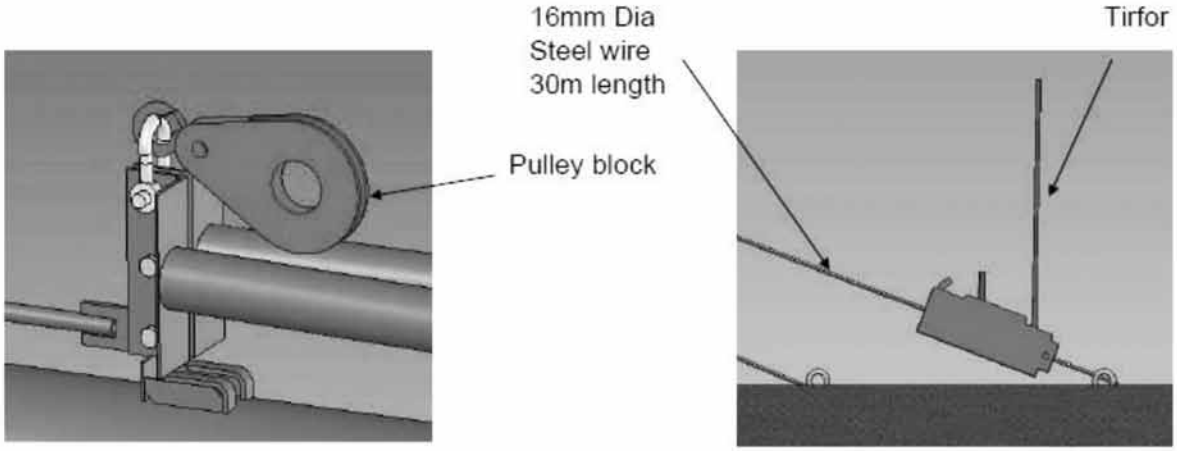
The ends of the Gin Poles are now bolted together through the central holes using an M24 x 100 Bolt, 2 x plain washers and 2 x full nuts.



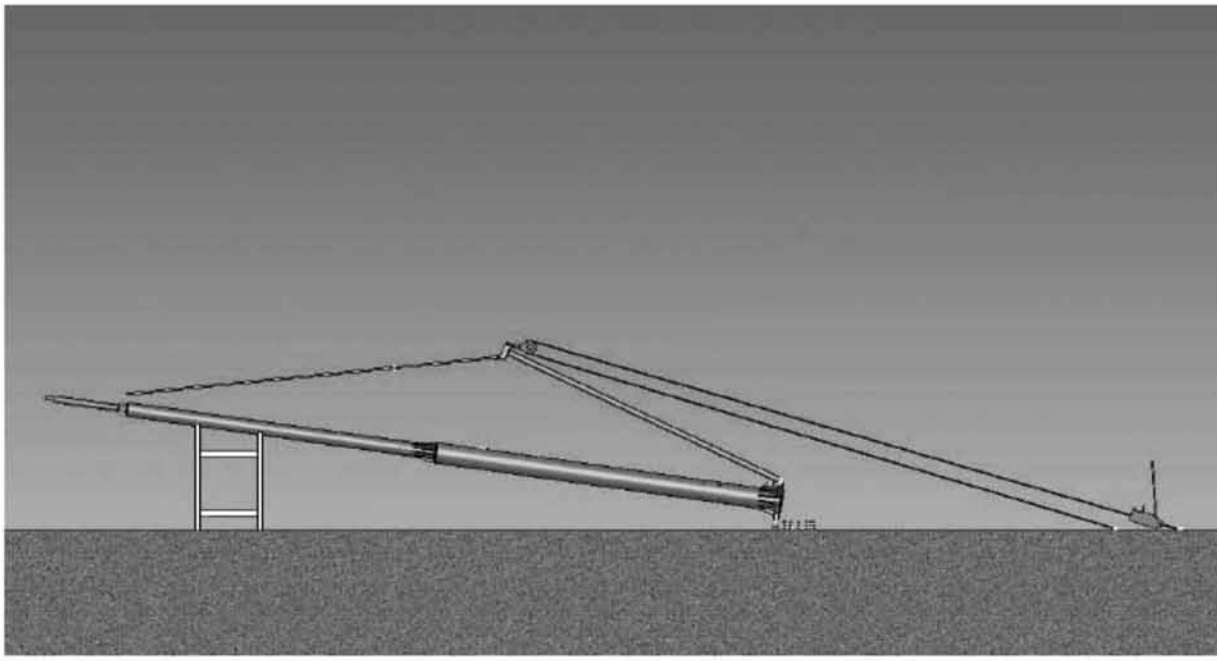
Fit the short tension member in between the two gin poles and bolt in position through the bottom hole using M24 bolt. This connection must not be over-tightened, as it must pivot during erection



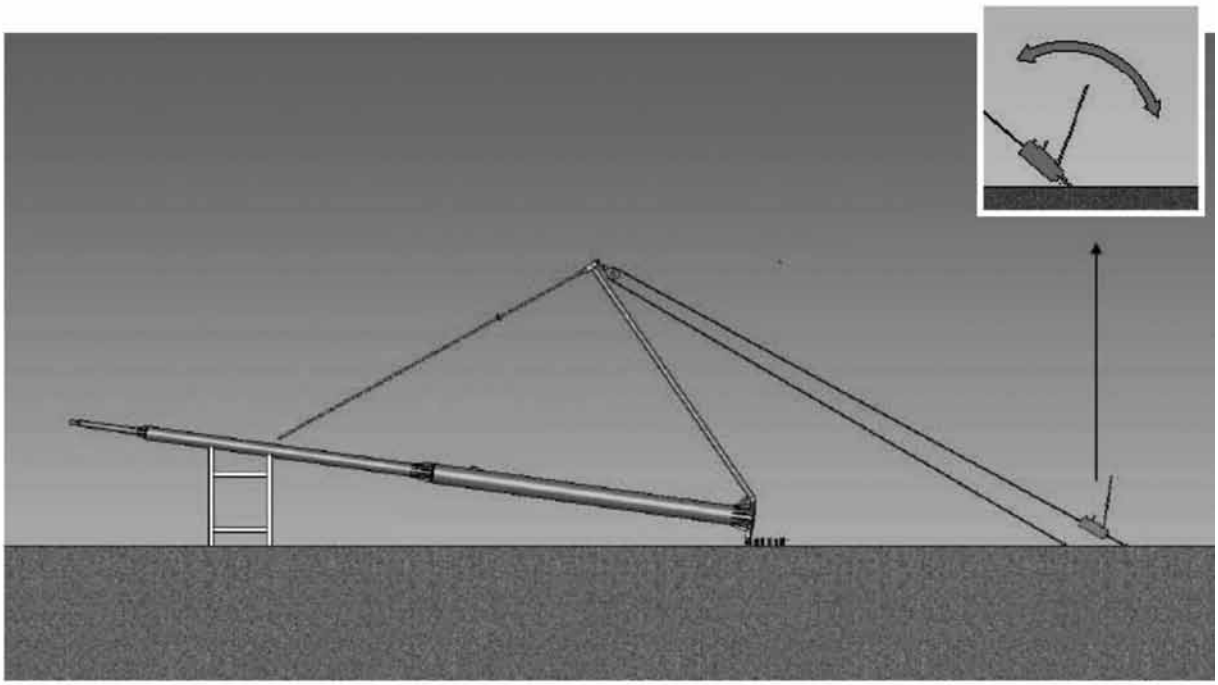
Attach the long tension member to the short tension member via the bolted connection using 2 x M20 bolts.



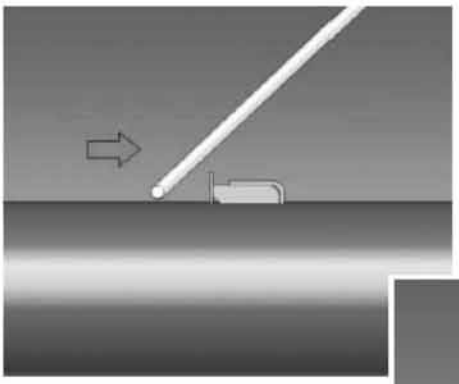
Install a suitable pulley block onto the end of the pulley plate. Attach one end of 16mm steel wire to the forward anchor point using a suitable shackle. The wire is then run through the pulley, and back towards the anchor pad. The Tirfor should be attached to the rear anchor point via a short strop. The steel wire is then run through the Tirfor and locked in (see Tirfor instructions).



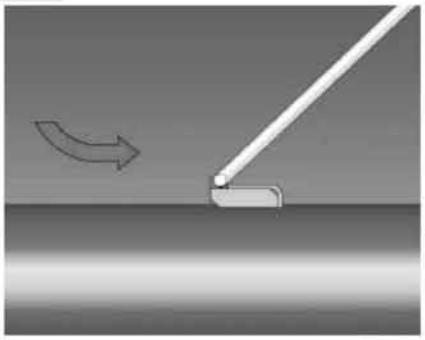
Note: The gin poles will need to be manually lifted to a suitable angle to allow lifting with the tirfor (As shown above).
By moving the Tirfor handle back & forth any slack can be taken up before beginning to lift the gin poles.



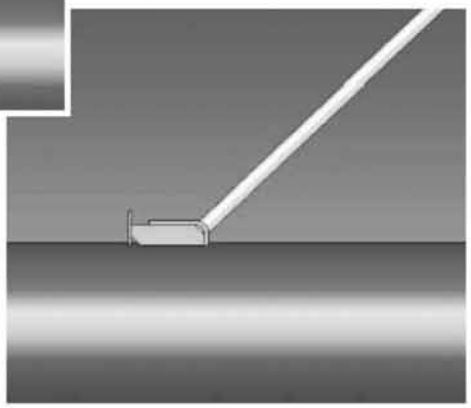
As the gin poles are being lifted, the long tension member is moving down the pole towards the tension member bracket mounted on the pole. Have someone ready to guide the end of the tension member into the bracket to allow the pole to be lifted.



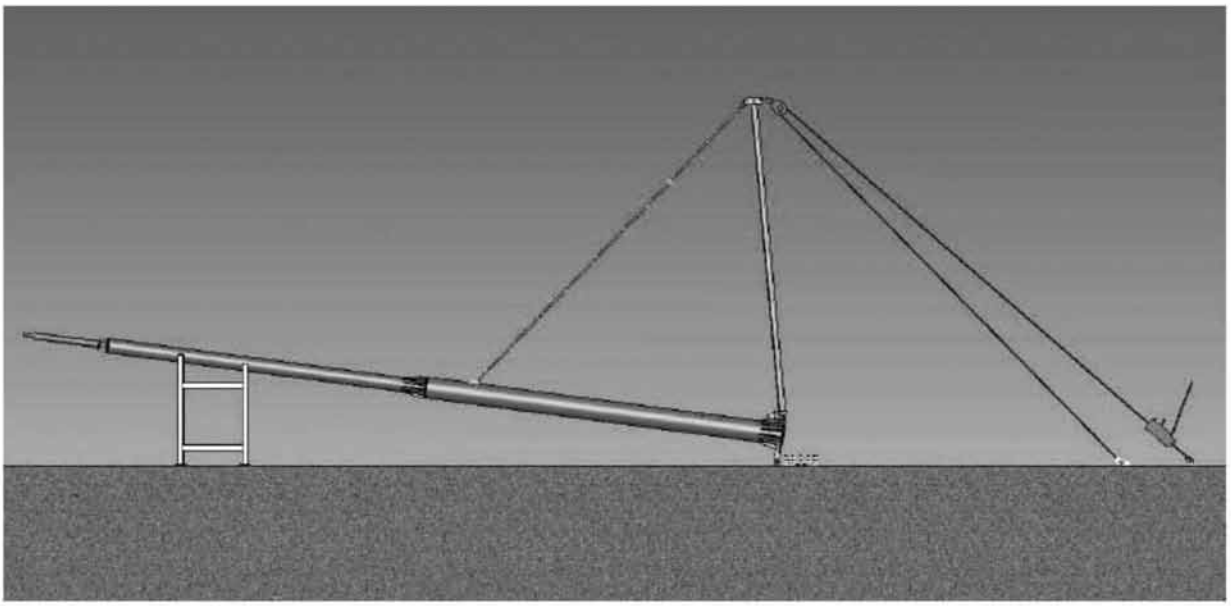
As the gin poles are being lifted, be ready to guide the tension member end into the bracket on the pole structure



Tension member to be guided into tension member bracket as it slides along the pole whilst being lifted



Once the end of the tension member is in place, the pole can be lifted



The turbine head is now ready to be installed onto the pole structure.

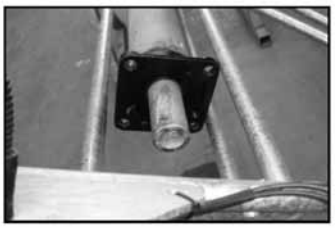
3.3 Connecting the Wind Turbine Head to the Tower Top

3.3.1 Procedure

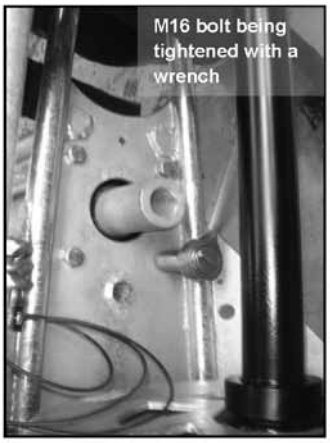
- Prepare tower for fitting with the head

NB: When lifting the wind turbine head attach the slings to the main shaft only. Never lift using the wind turbine frame tubes.

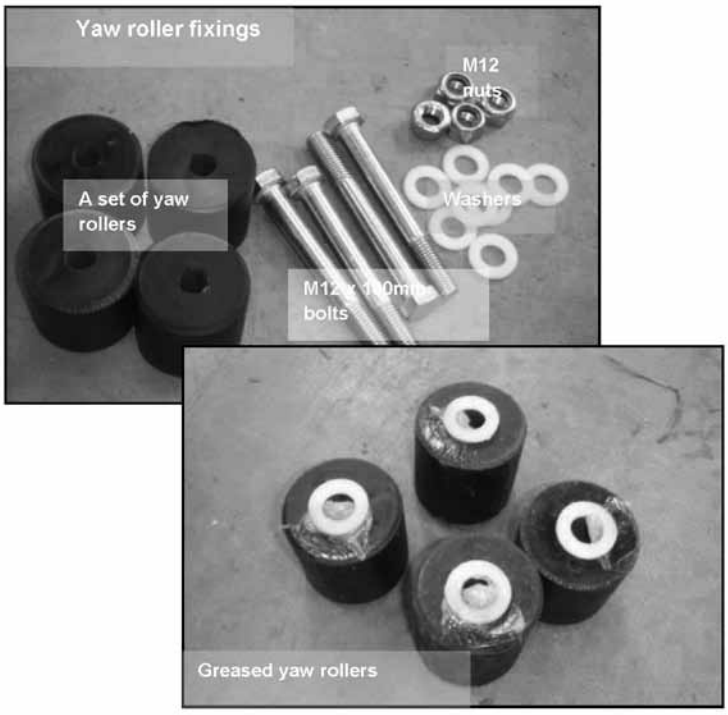
- Fit yaw bearing on to spigot ensuring grease nipple is accessible and push wind turbine head fully home. If slip ring brushes are fitted then be careful not to damage brushes when pushing head fully home.



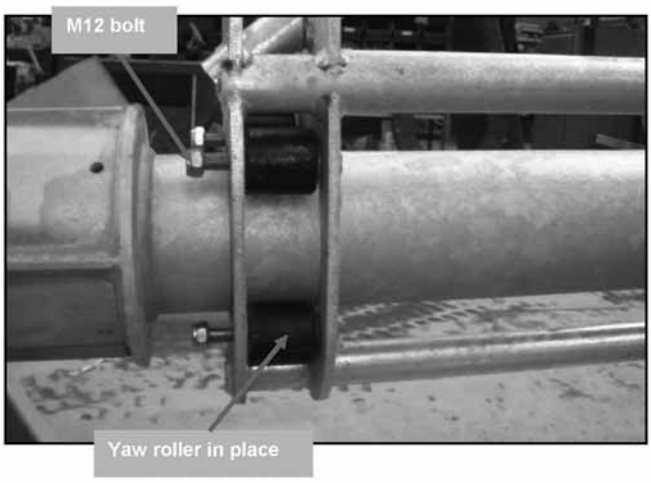
- The yaw bearing fixing bolts (M16) can now be tightened. The wind turbine head can now rotate around the tower. Withdraw the head assembly back off the tower approximately 50mm, spread some thread locking compound (Loctite 577) onto the spigot and push head fully home. Tighten bearing grub screw using a 5mm allen key. The thread lock compound ensures a secure fit between the spigot and the bearing. It is also recommended to glue in the grub screws to stop them vibrating loose.



- Prepare yaw rollers and bolts for fixing by greasing the bolts and roller ends



- Fit the yaw rollers. Fit bolt through yaw frame hole as shown below, and guide it through the roller and nylon washer and through thelower frame hole.



- Tighten the yaw roller bolts using a 19mm ratchet and 19mm spanner. The nuts fitted to these bolts only need to be tightened up to the plate – they do not need to be torqued. Do not over tighten the rollers so that they can rotate
- Check that the wind turbine will freely rotate within its yaw axis.
- Finally spin the rotor by hand to check that nothing rubs. If the wind turbine has been roughly handled then the domed generator cover can get pushed against the magnet plates. If this is the case gently tap the cover back into position and reseal if necessary

A wedge can be used to gently position the yaw frame allowing for the lower yaw rollers to be installed with ease.

Important

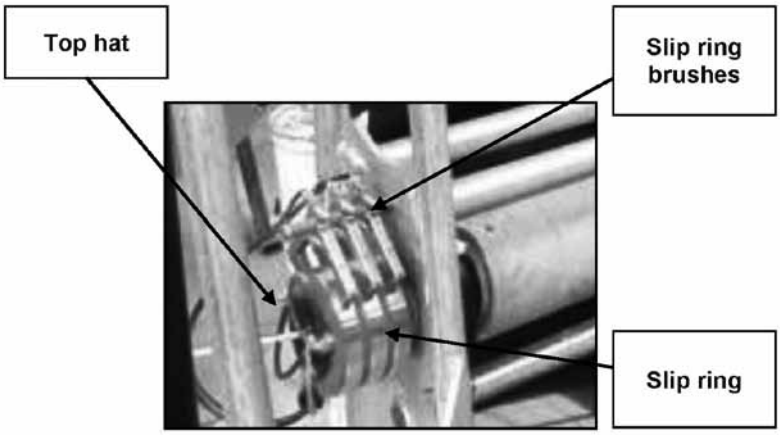
Mechanical and electrical installations will be required in the nacelle of the wind turbine.
If the wind turbine head is above normal working height provision will have to be made for scaffolding or other safe means of access.

3.4 Slip Ring Assembly

3.4.1 Description

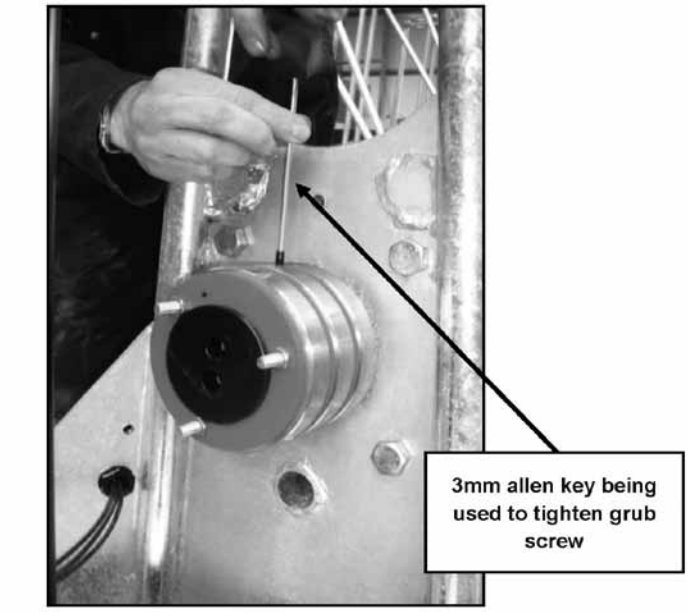
A slip ring is an electromechanical device that allows continuous electrical connection and transmission of power from a stationary to a rotating structure. Additionally, the slip ring helps prevent the down cable and brake rope from twisting. The slip ring assembly consists of:

- Slip ring including grub screws
- Mount stand for slip ring brushes
- Slip ring brushes for each ring



3.4.2 Procedure

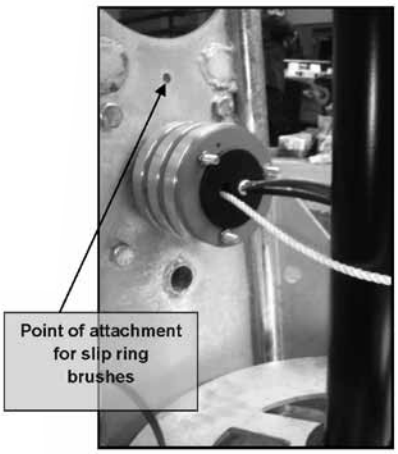
Smoothen the tower spigot surface to be fitted with the slip ring using sand paper. If cable is fitted at this stage then feed cable through the slip ring and top hat. If not the fit slip ring onto spigot, fit top hat into the end of slip ring so that it butts up against the end of the tower top This is the position the slip ring should be secured in. Slide back the slip ring and top hat and apply Loctite to the spigot and then re-fit and secure using the grub screws. Use a 3mm allen key to fix grub screws in place - use Loctite on grub screws.



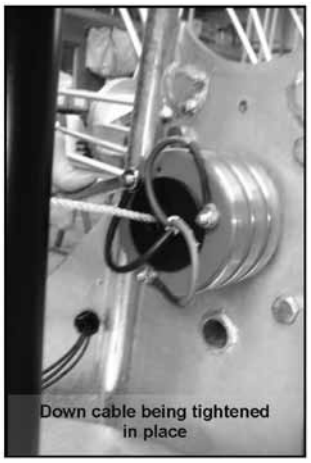
Slip Ring Connections

This assumes brake cable and down cable are in position and are fitted through top hat assembly

- Using two 17mm spanners attach the slip ring brushes to the frame. Again be careful not to over tighten as the tube can break

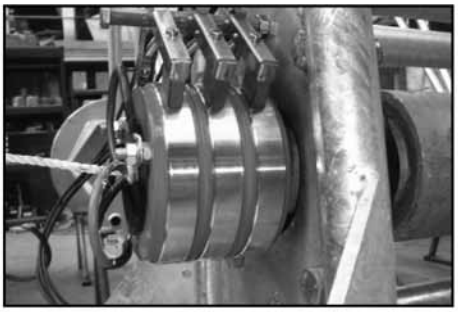


- Loosen the 3 stud nuts on top of the slip ring unit and connect the down cable ends at the top hat to the 3 studs. Tighten the stud nuts with a 13mm spanner. Do not over tighten as you may shear the copper stud.Vibration washers are included to ensure a secure fit.

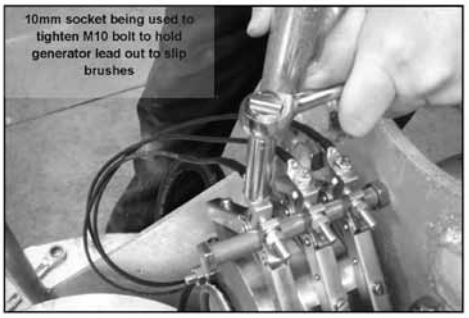


Note: Any cable can be connected to any stud.

- With a 10mm socket loosen the bolts on the brushes till the brushes can be moved freely. Position the brushes in the middle of the rings. Adjust for good contact and then tighten bolts.



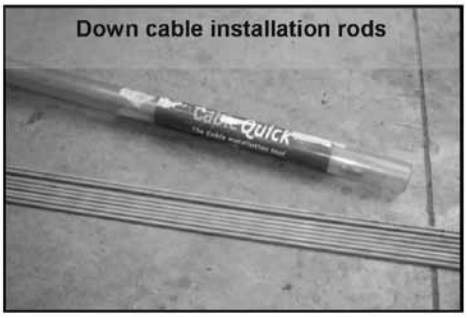
- Connect the generator lead out wires to the top of the brushes and tighten using a 10mm socket.



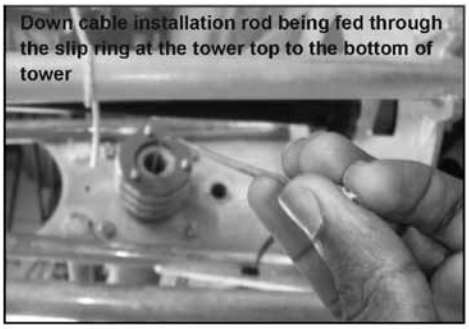
3.5 Preparing the Cable Termination at the Wind Turbine Head end

3.5.1 Procedure

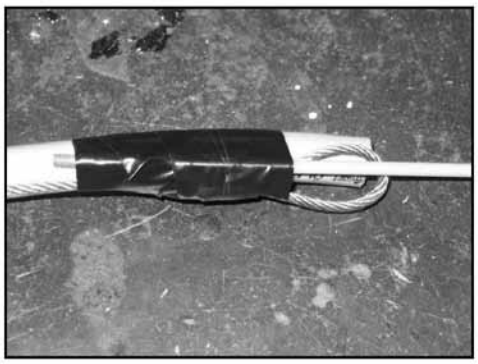
- Assemble down cable installation rods (not supplied) so they are long enough to match tower height. Alternatively a draw string or other suitable methods can be used to pull cable down from the top of tower to the bottom.



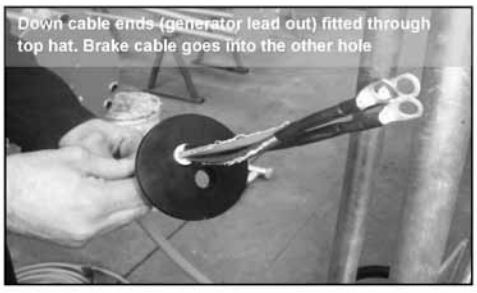
- Feed the assembled installation rods (now a long rod) through the slip ring at the tower top to the bottom of the tower.



- Using an adhesive tape, attach the brake cable and down cable tothe assembled installation rod. Feed the rod down through the spigot and pull the end of the rod at the bottom of the tower until other end with the attached rope appears. Now detach the rod from the down cable and brake rope.



- Feed the end of the down cable at the top of the tower through one hole of the top hat and similarly feed the remaining hole with the brake cable.



- Now fit the top hat to the slip ring.

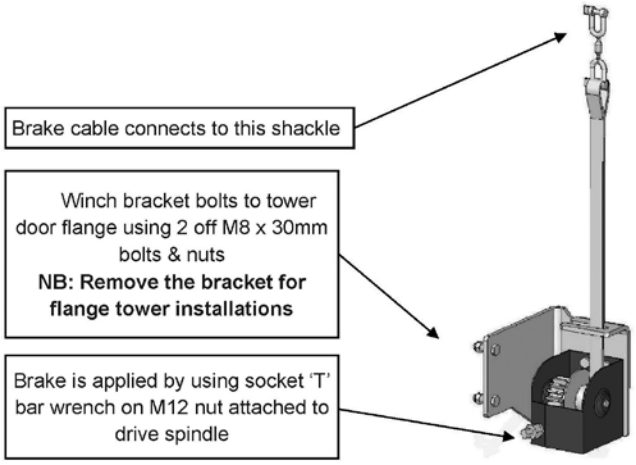
3.6 Brake Rope Installation

The mechanical brake assembly is made up of the following components located in the nacelle of the wind turbine:

- Brake disc
- Brake pads
- Brake lever, which is already factor fitted,
- Steel shackle which is fitted to the end of the lever.
- Steel shackle which is fitted to the brake cable guide bar.

Other components located in the tower section are:

- Worm geared winch mechanism (this includes a short webbing strap).
- Two shackles and a swivel bearing (these are connected to the winch webbing)
- Socket 'T' Bar Wrench.


Brake cable connects to this shackle
Winch bracket bolts to tower door flange using 2 off M8 x 30mm bolts & nuts
NB: Remove the bracket for flange tower installations
Brake is applied by using socket 'T' bar wrench on M12 nut attached to drive spindle

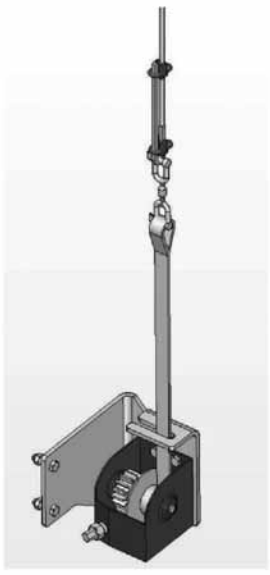
3.6.1 Procedure

Fit winch assembly to the tower door flange, secure using supplied nuts and bolts. See 3.6.2 for installation on flange bolted towers.

Attach the end of the brake cable from within the tower to the shackle on the end of the winch webbing strap.

The free end must be attached to the winch end (as shown below)using a swivel and a shackle, the wire should be fed through and around the pin of the shackle and adjusted to suit, finally being secured with the two wire rope grips supplied. Make sure that the brake winch is payed out before the cable is secured.

Using 3mm rope - two grips are required to secure the end of the rope.



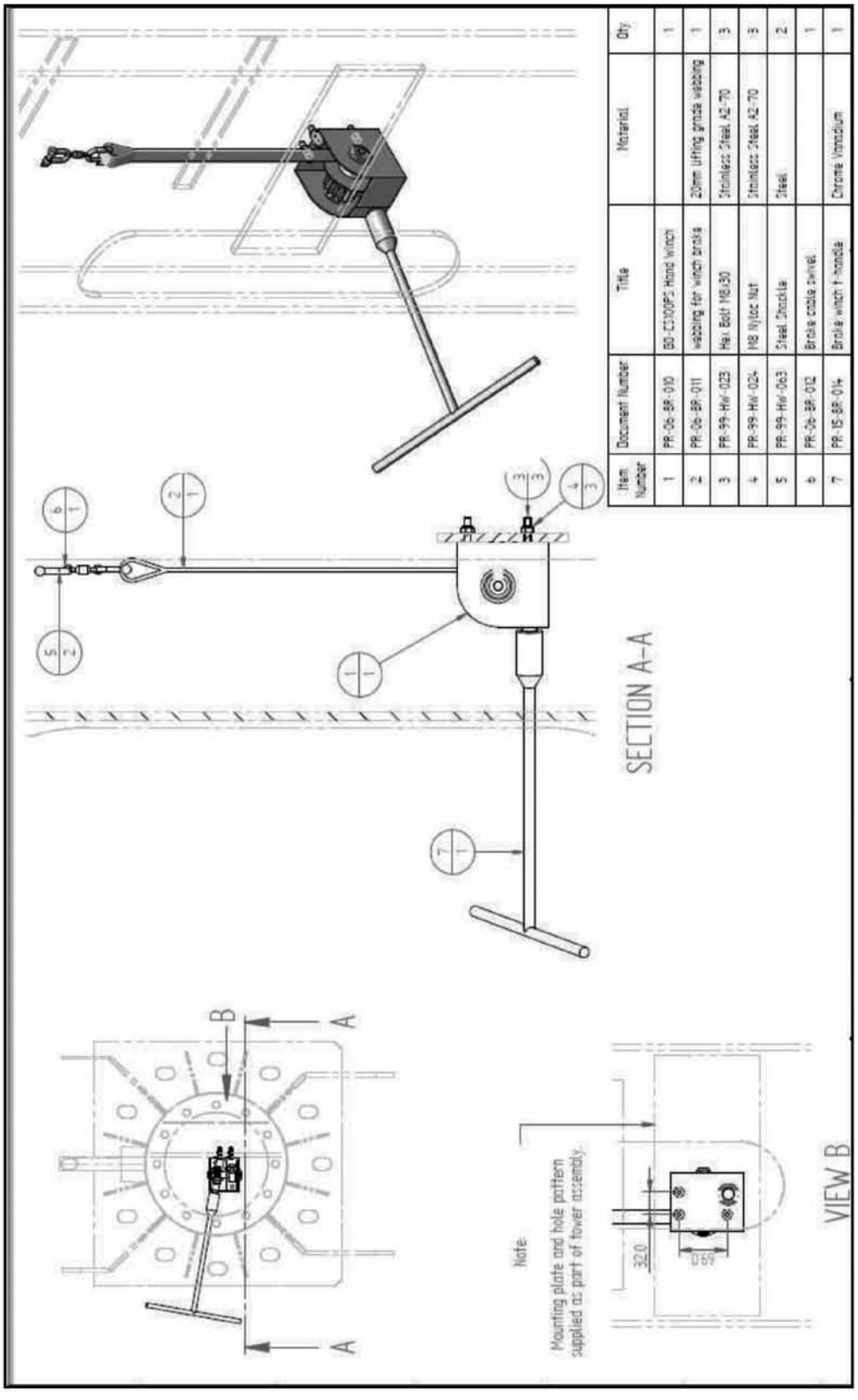
The grips should be fitted in such a way that the correct tightening of the grip does not damage the outer wires of the rope grip.

Position the clips and apply light tension on the rope and tighten all nuts evenly, alternating until reaching the specified torque.

Length of rope to turn back: 85mm

3.6.2 Procedure for Flange Bolted Towers

Remove the bracket and install the winch directly to the mounting plate located inside the tower as shown below.



Item Number	Document Number	Title	Material	Qty
1	PR-06-BR-010	BD-CS100PS Hand Winch		1
2	PR-06-BR-011	webbing for winch brake	20mm lifting grade webbing	1
3	PR-99-HW-023	Hex Bolt M8x30	Stainless Steel A2-70	3
4	PR-99-HW-024	M8 Nyloc Nut	Stainless Steel A2-70	3
5	PR-99-HW-063	Steel Shackle	Steel	2
6	PR-06-BR-012	Brake cable swivel		1
7	PR-15-BR-014	Brake winch t-handle	Chrome Vanadium	1

3.7 Fitting the Covers

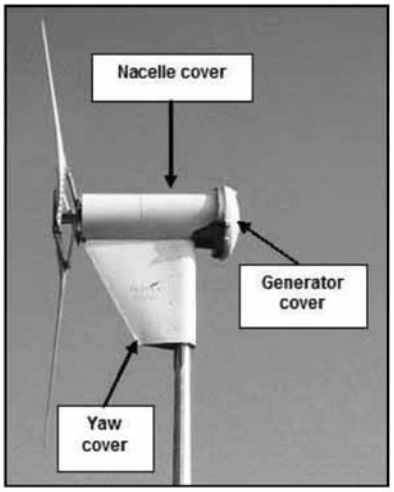
The wind turbine is supplied with the following covers:

- Generator cover (nose cone)
- Yaw cover
- Nacelle cover (also called the rotor shaft cover - supplied in two pieces)

The covers are made from black or white U.V. stabilised polypropylene plastic. They are fitted to the wind turbine frame using cable ties. The two–piece nacelle covers are stitched together after fitting to the wind turbine frame individually.

The yaw cover is fitted first!

NB. Kingspan does not recommend painting of the covers as the paint would peel off after a short while.



3.7.1 Fitting the Generator Cover

The generator cover is secured over the electrical generator by means of an SS "Jubilee clip". The wind turbine is supplied with the cover already fitted.

3.7.2 Fitting the Yaw Cover

Procedure

Step 1: Offer up yaw cover to the frame and attach using the cable ties. Feed cable tie from front through cover around the steel bar and back through the other hole, secure tie but do not fully tighten until all ties have been fitted.

Step 2: Fold the cover around the frame under the generator end and secure the cover to the frame as in step 1.

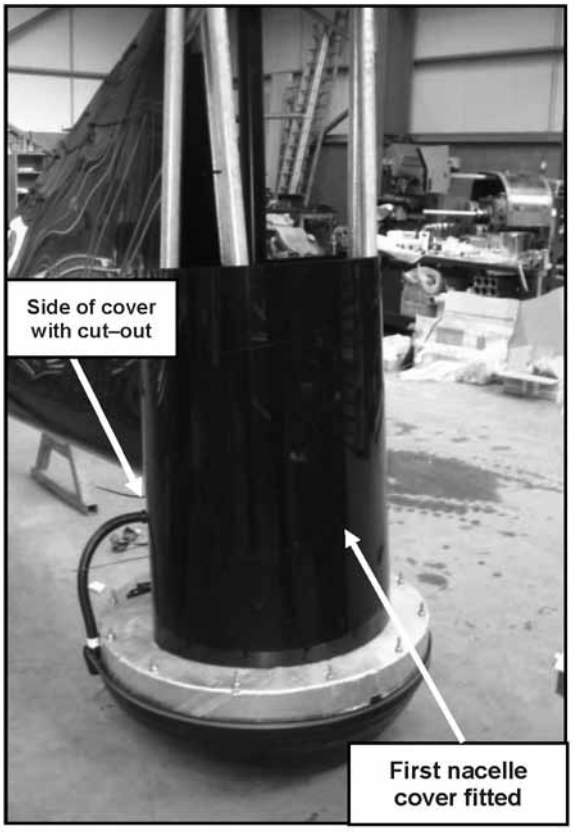
Step 3: Finally tighten all ties and trim

3.7.3 Fitting the Nacelle Cover

Procedure

Step 1: Offer up the first nacelle cover to the frame, attach using the cable ties. Feed cable ties through cover then through plate and back through cover and secure. This joins cover to frame. It may be necessary to join cable ties together to get the required length.

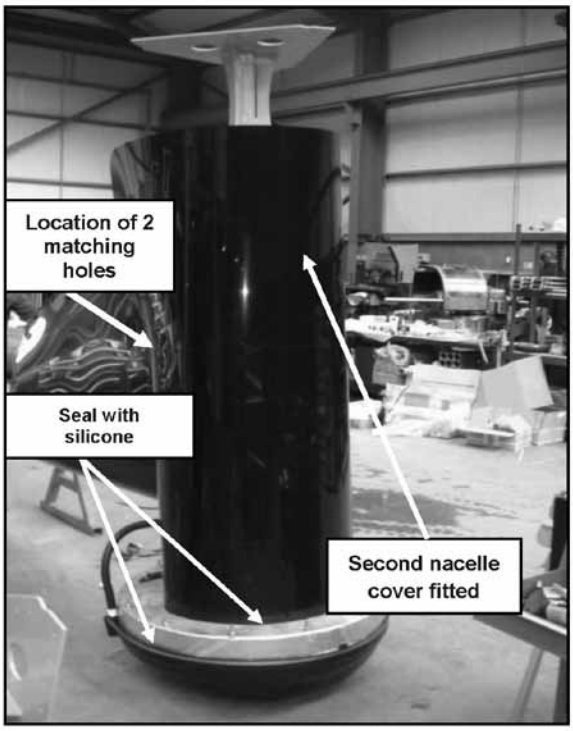
Step 2: Fold the cover over and around the frame and secure as in step 1. NB: Fold cover such that the side with the cut–out fits onto the conduit containing the generator lead out wires.



Step 3: Offer up second nacelle cover to the frame. Fold around the frame and fit this cover under the edge of the first nacelle cover as shown. Loosely stitch the cover parts together using cable ties. When stitching these parts together be sure to go around the frame as well. NB: Line up the two matching holes on either side of both covers before securing the rest of the cover to the frame.

Step 4: Fit ties through the rest of the cover holes and around frame parts. Finally tighten all cable ties and trim.

Step 5: Seal the edges of the generator cover & first nacelle cover using silicone supplied.



3.8 Blade Assembly

Caution: Treat the blades with exceptional care – especially the leading and trailing edges of the airfoil. Blades are supplied as a balanced set of three. Do not mix and match.

3.8.1 Blade Description

The blades are made of the following parts

- Airfoil – Glass polypropylene composite
- Zebedee hinge at blade root – Polyurethane
- Root of blade – Galvanised steel

These three parts are supplied already assembled.

3.8.2 Fitting the Blades

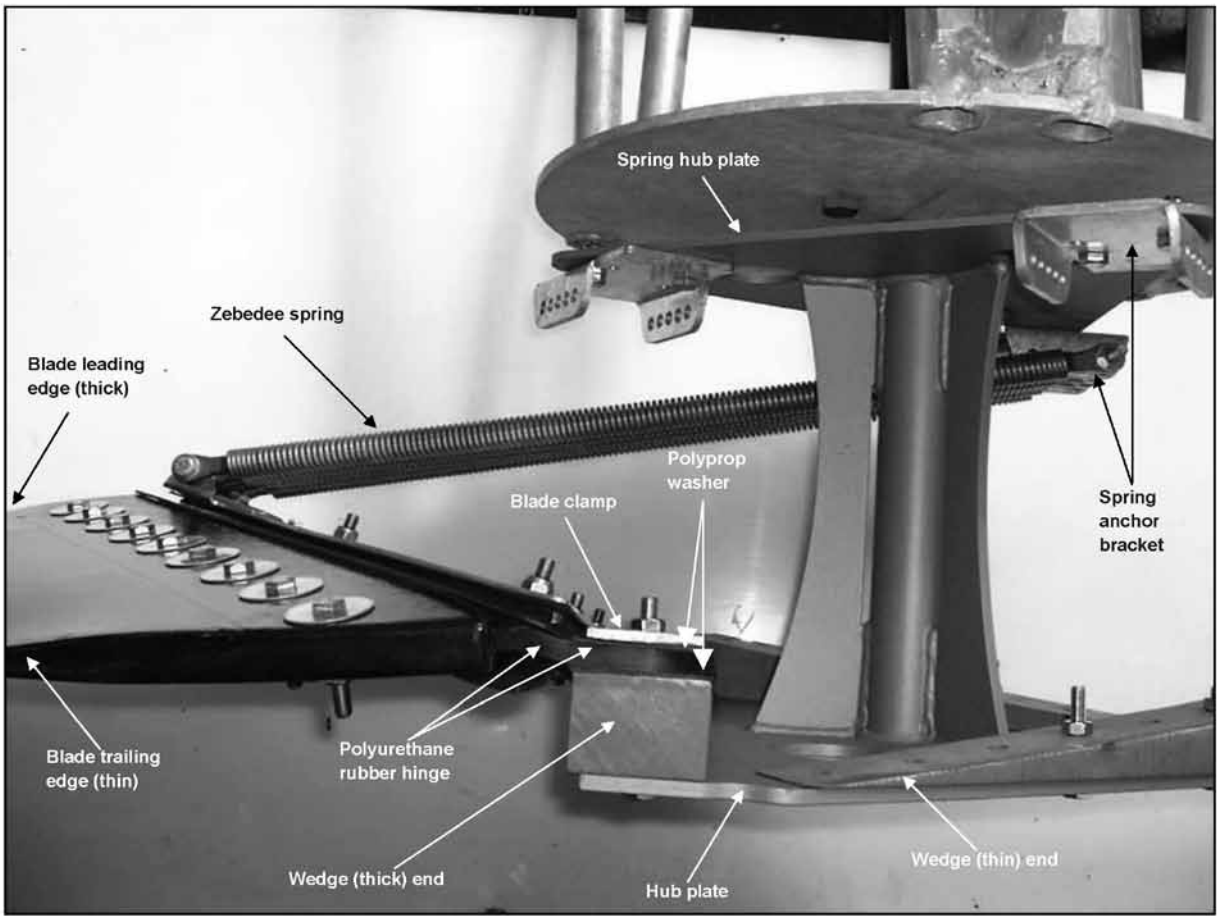
Procedure

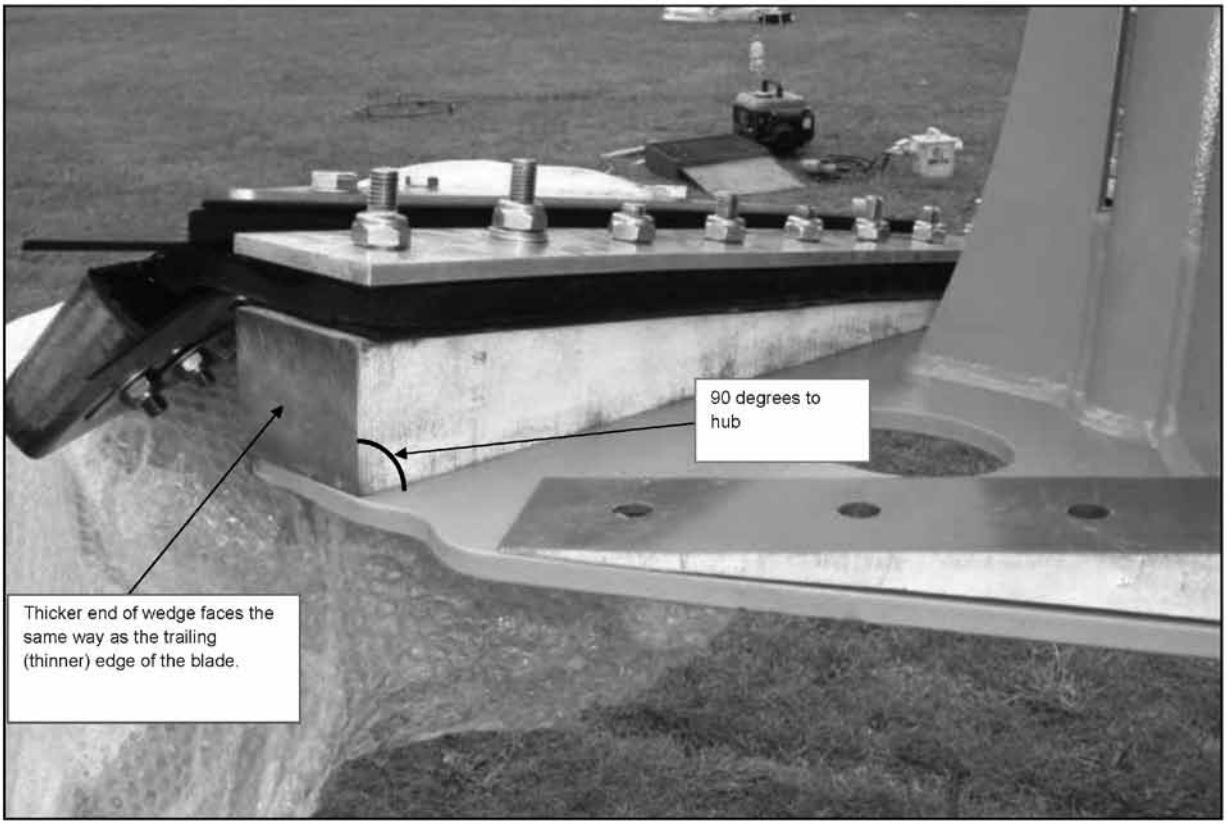
- Put polyprop (plastic) washer on top of wedge
- Place PU (rubber) hinge of blade on top of washer
- Place further washer on top with metal clamp plate as final layer
- Secure blade using M10 bolts (35Nm) and lock nuts provided.
- Use thread lock on bolts. Only a small amount on each bolt.
- Proceed to attach springs

Information

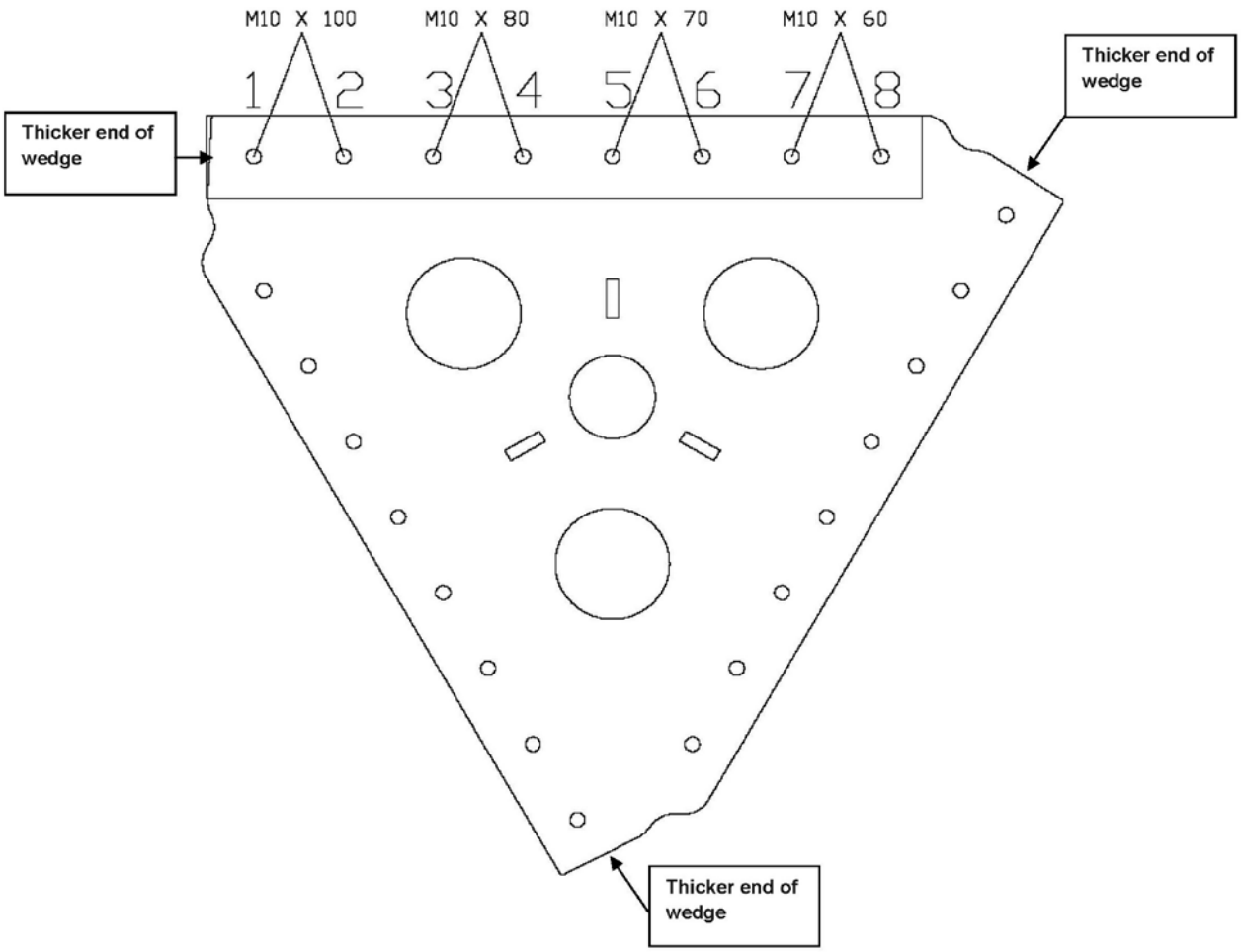
The blades are bolted to the hub plate by means of:

1. SS bolts provided
2. Galvanised steel clamp plates provided
3. Polypropylene clamp washer provided.





NB: White wedge for illustration only - Your Kingspan wind turbine is delivered with black wedges which have a pip to fit in the corresponding hole in the rotar to ensure correct installation.

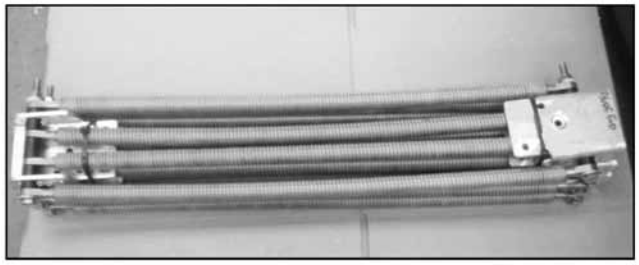


Caution

Ensure that the blades and wedges are put the right way or else the wind turbine will overspeed resulting in high voltage being transferred to the controller and inverter.

3.9 Zebedee Spring Assembly

3.9.1 Description



The Zebedee spring assembly consists of the following per blade:

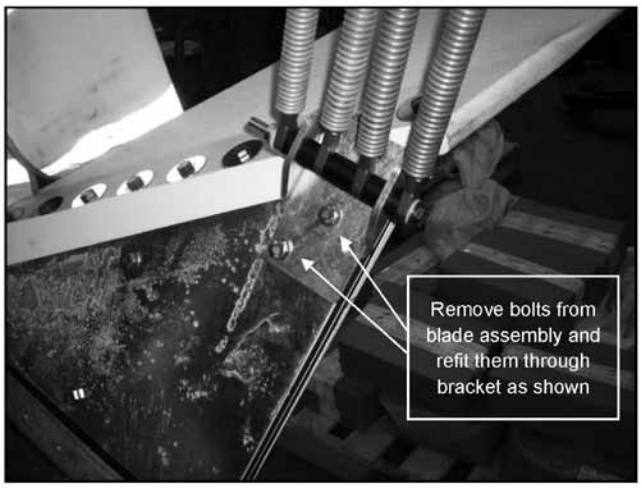
- Zebedee spring assembly made up of 4 individual springs
- U-bracket for connection to spring hub plate
- U-bracket for connection to blade root

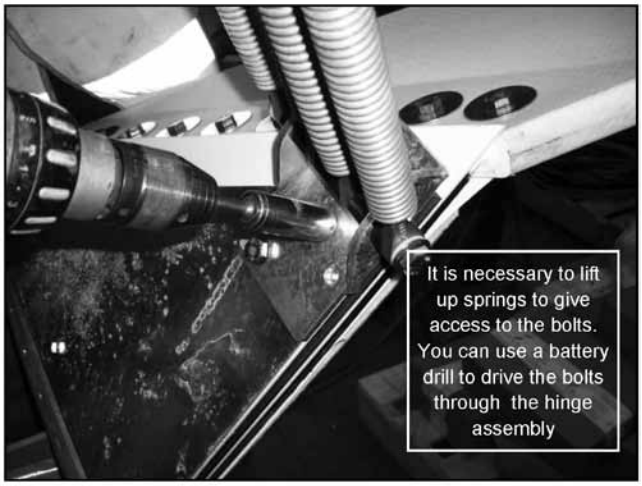
These three items are normally supplied already fitted together.

Fitting the Zebedee Spring Assembly

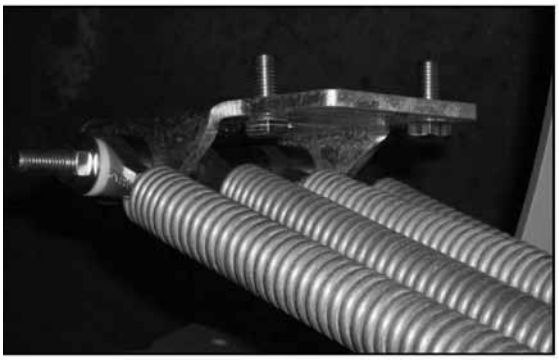
3.9.2 Procedure

Springs are marked 'BLADE' and 'ROTOR' respectively the brackets will also have an indication of the holes to be used.

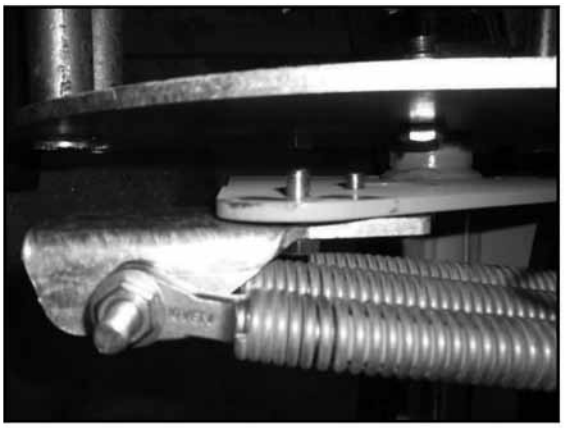


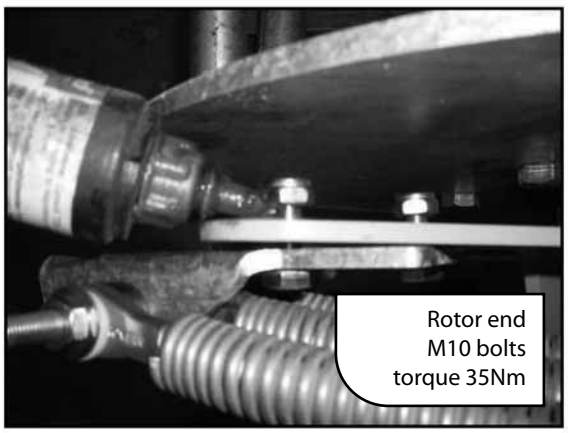

It is necessary to lift up springs to give access to the bolts. You can use a battery drill to drive the bolts through the hinge assembly

Insert spring anchor fixings into holes in the bracket. Do this prior to offering up the bracket to the rotor plate. Note it may be necessary to bend the springs slightly in order to get them into the correct fitting position

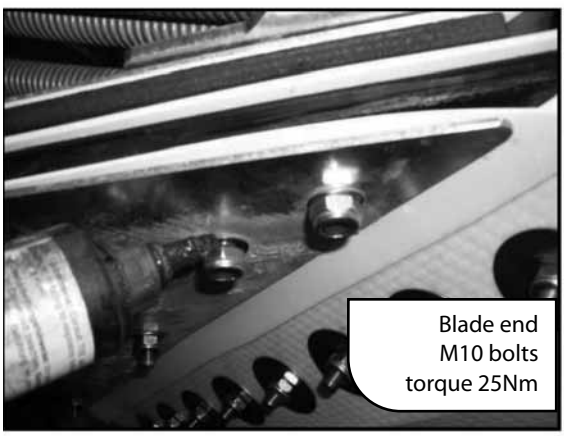


Fit bracket to rotor plate and secure with nyloc nuts and threadlock liquid as shown.

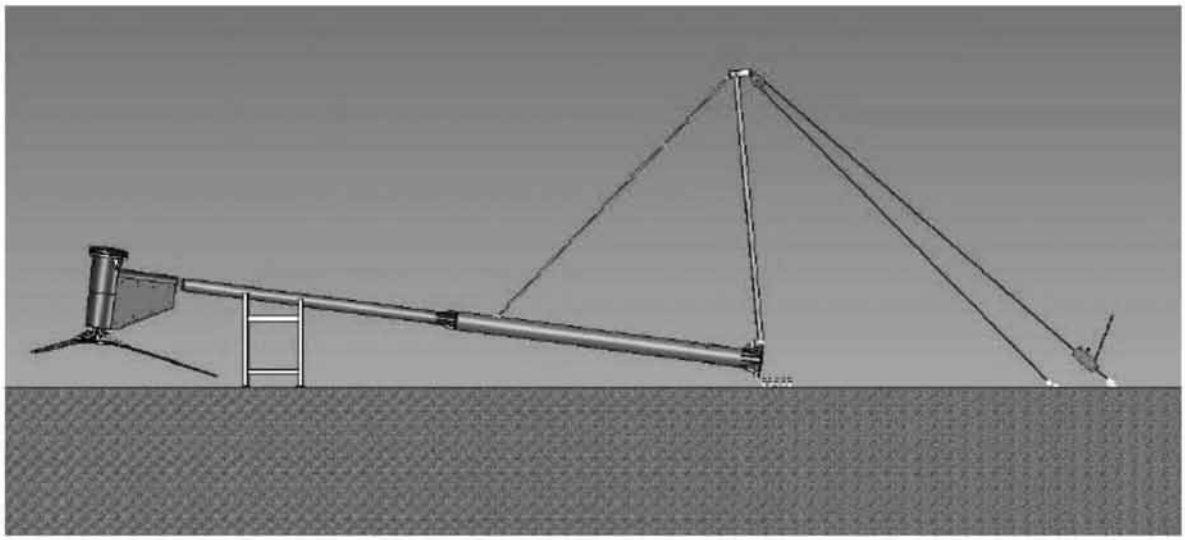




Apply thread lock to blade side and secure all fixings as per specified torque values. Repeat for all blades, ensure all brackets are tight



3.10 Raising the Wind Turbine (Procedure Provided by Hutchinson Engineering)

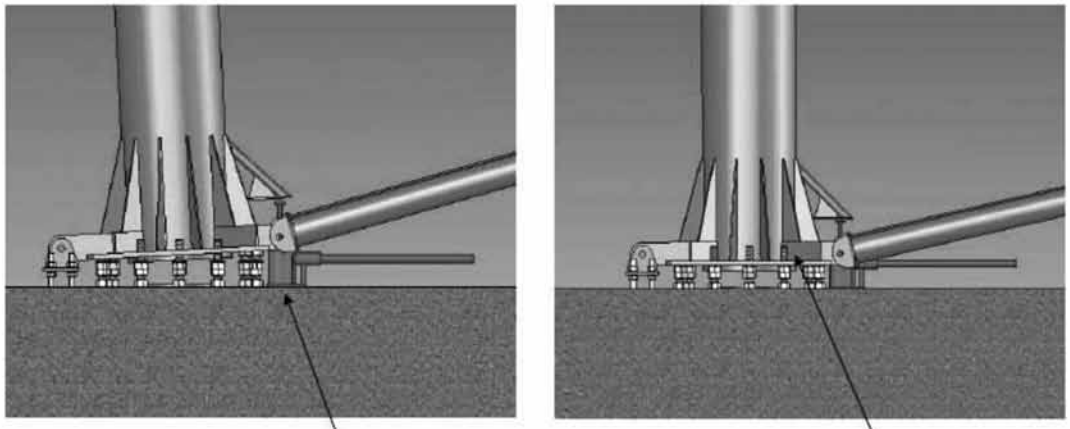


Clear the lifting area of all non essential personnel. Do not allow anyone to be in the vicinity of the wind turbine whilst raising and lowering

With the pole structure resting on the trestle, ensure that any slack is taken up using the Tirfor

1) Check that the cables will not be trapped under the pole base
2) Apply the wind turbine brake
3) Pull wind turbine up slowly using the Tirfor

4) As the pole is being lifted, an extended bottle jack can be placed in position under the jacking point to allow a controlled conclusion to raising the pole.

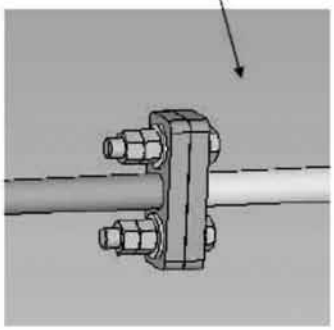


5) Slowly lower the bottle jack until the pole is upright, and the base plate is sitting on levelling nuts
6) When upright keep the tension on the rope until all of the M30 base nuts have been levelled & tightened
7) When all bolts are tight, only now can the tension be released on the steel cable

See page 33 for tower bolt torque settings

Care must be taken when dismantling the gin pole arrangement. The gin poles are heavy. Injury could result from mishandling

8) Dismantle lifting tackle (i.e. pulley, Tirfor, steel cable etc)
9) Undo the M24 bolt holding the end of the short tension member to the top of the gin poles
10) The two main gin poles will now pivot down to the ground – Caution these are heavy items
11) The gin poles can now be disconnected from the base of the pole
12) Undo the two M20 bolts connecting the long and short tension member together
13) Release the long tension member from the bracket mounted on the pole. This is done by walking toward the pole holding the tension member until vertical lift slightly and pull forward. The tension member can now be withdrawn from the front of the bracket.



3.11 Lowering the Wind Turbine

Lowering the turbine:

Clear the area of all non essential personnel. Do not allow anyone to be in the vicinity of the wind turbine whilst raising and lowering

1) Apply the wind turbine parking brake. Place trestle (allow clearance for turbine blades) to support tower when lowered.
2) Bolt both gin poles to base plate (fig.1)
3) Bolt gin poles together - do not fully tighten at his point(fig.2)

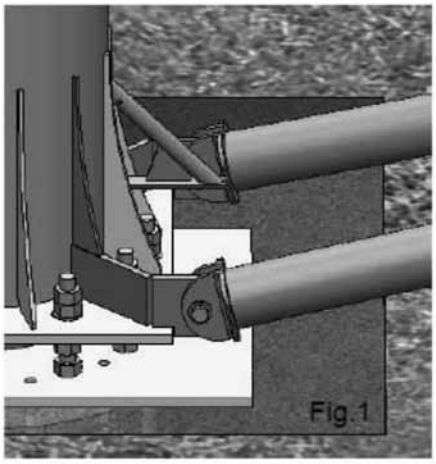


Fig.1

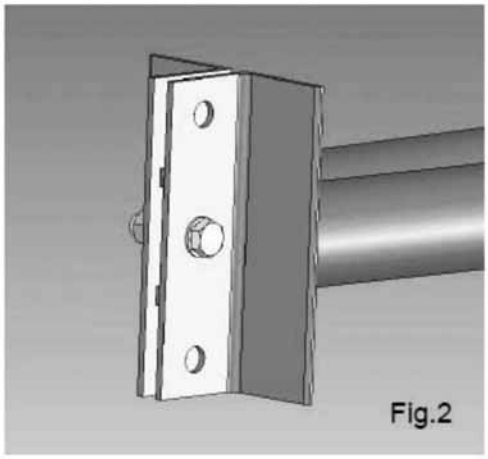


Fig.2

4) Attach the long tension member to the fixed bracket on the pole - offer up from the front, push through slot, pull down so that the end of the rod is located in the radius of the bracket and walk back towards anchor pad (fig.3)
5) Attach the short tension member to the end of the longer tension member (fig.4)

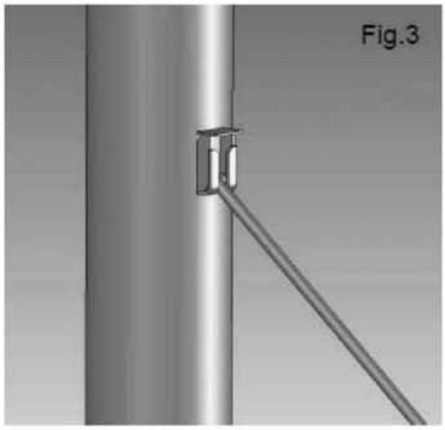


Fig.3

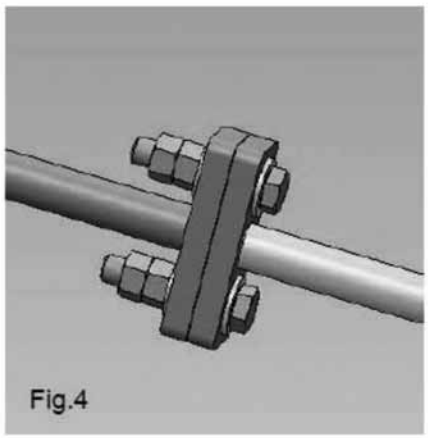


Fig.4

6) Lift the gin poles up off the ground and attach the end of the short tension member between the gin poles through the top hole (fig.5) Tighten both M24 bolts at the gin pole apex

7) Attach lifting tackle (i.e. Tirfor, pulley, steel wire etc). Ensure all bolts and fasteners are tight before lowering (fig.6)

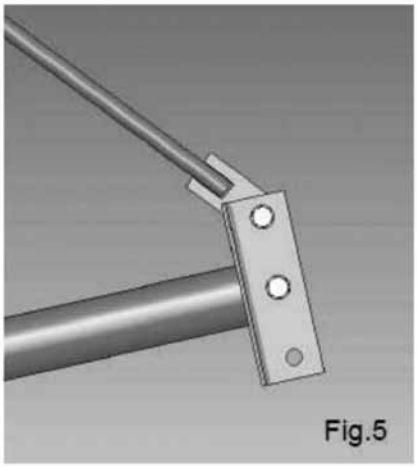


Fig.5

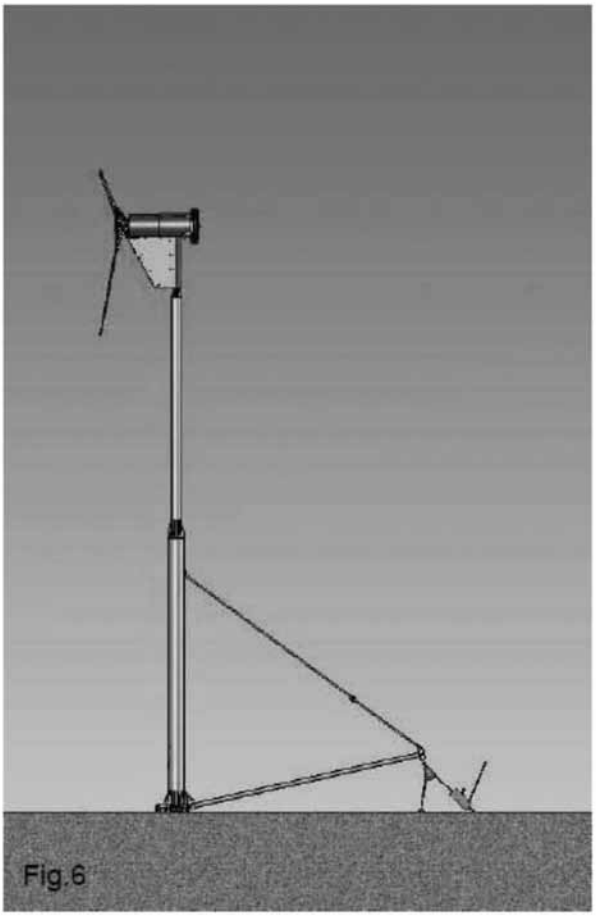


Fig.6

8) Take up slack in the steel wire using the Tirfor

9) Position the bottle jack under the jacking point (fig.7)

10) Remove base fixing fasteners

11) Pay out a little of the steel wire using the Tirfor (fig.8)

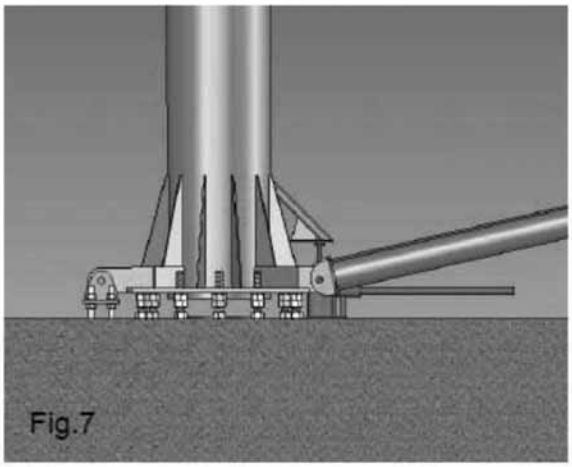


Fig.7

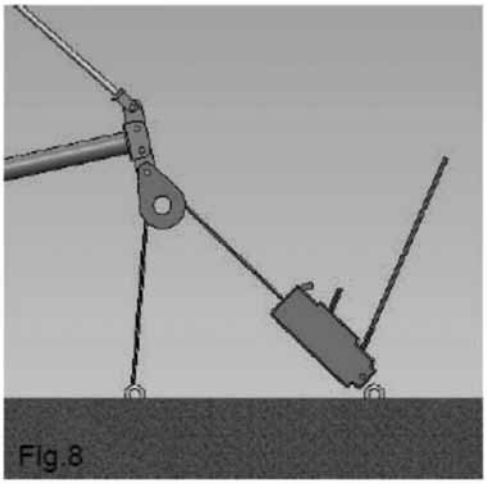
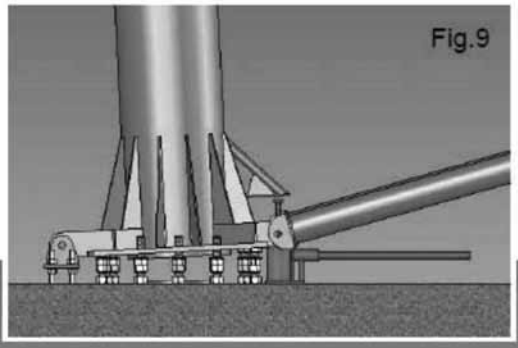


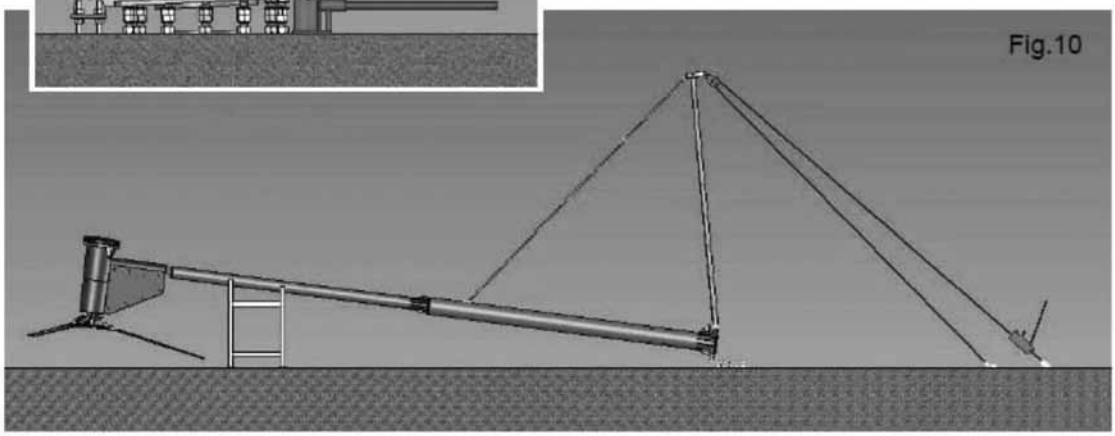
Fig.8

3.11 Lowering the Wind Turbine

11) Begin to jack the tower to approximately 3 degrees, in order to tip the tower over its centre of gravity (fig.9)

12) Now lower the tower gradually using the Tirfor, so that it comes to rest on the trestle (fig.10)





Tower Bolt Torque Table

All tower bolts should be tightened to the correct torque as per the following table. "Torque (Nm) with Locking Nut" applies to all double nuts both of which should be tightened to given torque setting. Make sure you are not using the higher torque settings for double nuts.

Bolt Size (Iso)	Torque (Nm) Without Locking Nut	Torque (Nm) With Locking Nut
M36	2370	1040
M30	1360	600
M24	690	300
M20	400	175
M16	200	90
M12	83	36.5
M10	47.7	21
M8	24.2	10.6
M6	10	4.4

NB: use the above table for tower bolts only.

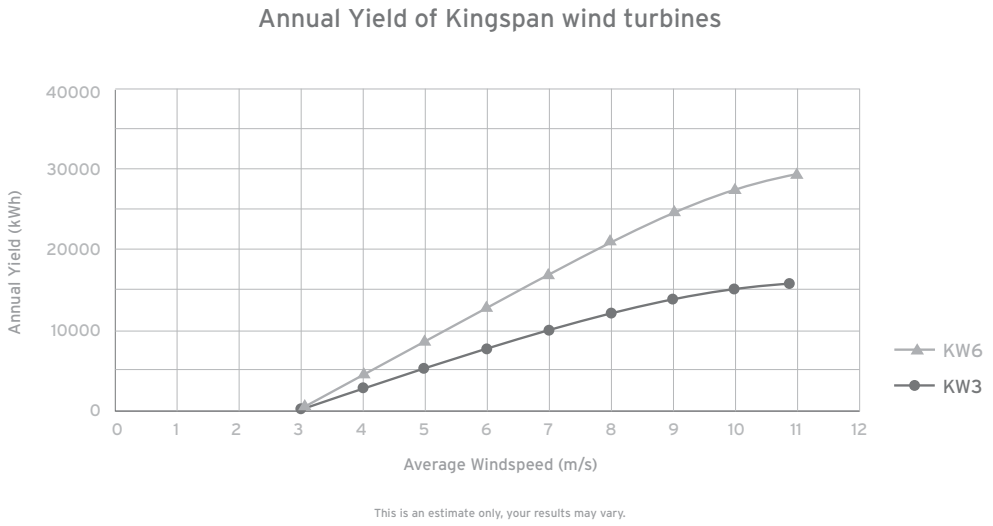
For wind turbine bolts follow torque settings given for individual bolts as they are application specific.

4.0 Wind Turbine Operation

Once installed and commissioned the KW6 wind turbine operates automatically

4.1 Annual Yield

Estimated annual yield graph above is based on a 15m tower, 15m anemometer height, turbine installed at sea level, ambient temperature of 15deg C, Rayleigh wind speed distribution. This is an estimate only; your results may vary.



KW6 Estimated annual yield figures:

Uave (m/s)	3	4	5	6	7	8	9
Annual Yield (kWh)	1384	3973	7780	12242	16704	20730	24113

4.2 Wind Turbine Output

The power output from the wind turbine can be determined from the meters installed. This is done by multiplying the instantaneous voltage reading in Volts on the voltmeter and the instantaneous current reading in amperes on the ammeter to obtain the instantaneous power in Watt. Note that 1 kilowatt (kW) = 1000 Watt (W).

4.3 Vibration

The wind turbine should run smoothly at all wind speeds. Any significant vibration of the wind turbine and tower assembly should be reported to Kingspan and the wind turbine stopped.

4.4 Noise

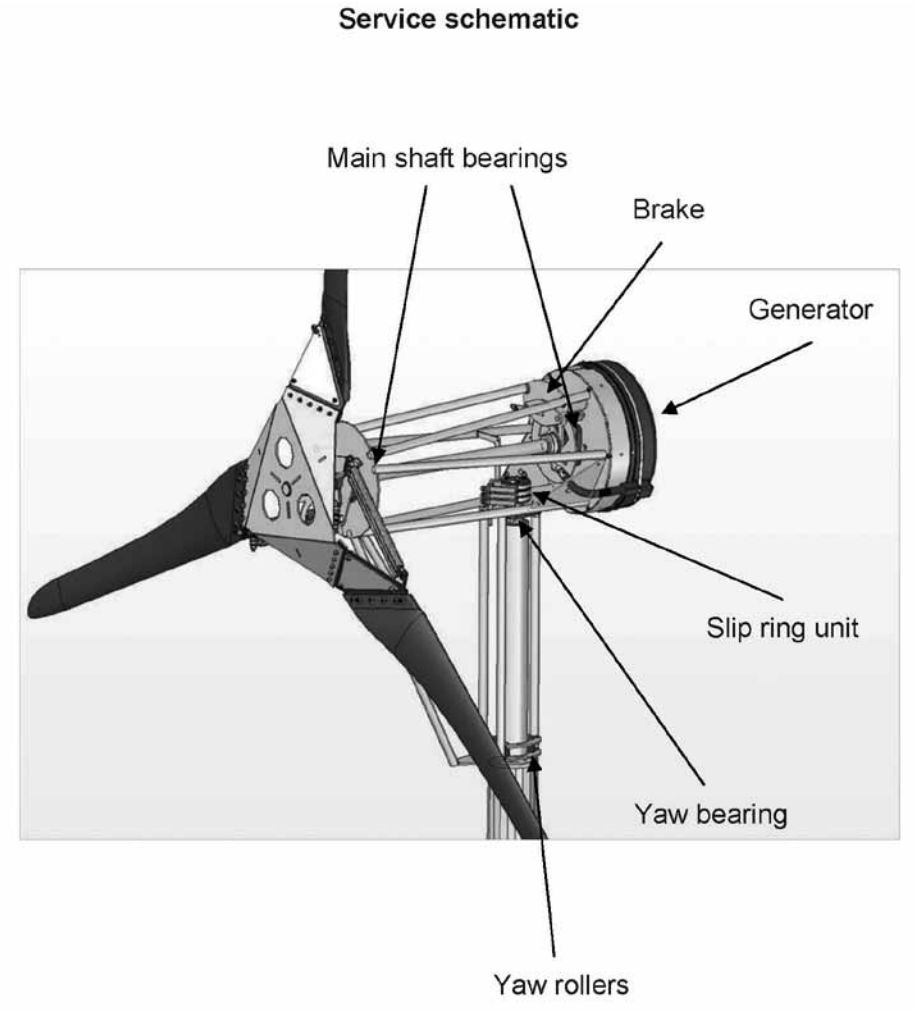
Virtually every device with a moving part makes noise and wind turbines are no exception. The wind turbine noise is produced by swishing sound from the blades as they rotate in the wind and is generally proportional to the wind speed and turbulence level. Kingspan wind turbines have low noise levels because they have no gearboxes which are a major source of wind turbine noise. It is therefore perfectly normal to stand underneath the wind turbine and practically have a conversation without shouting. At the rated speed however i.e. the speed where the blades cone in to limit power output to rated, the noise level will increase slightly. Other than that any non-air noise should be reported to your wind turbine installer.

5.0 Wind Turbine Maintenance

An annual service must be performed by a certified Kingspan wind turbine installer. We recommend an annual service and regular visual inspection to spot any unusual occurrence.

5.1 Annual Maintenance Main Points

- Lower wind turbine as described previously
- Grease main rotor bearings and yaw bearing housing (Use Lithium EP2 or similar multi-use grease). 1 or 2 full grease gun pumps is recommended. Do not overfill the bearings.
- Clean slip-ring assembly with Scotch-Brite HD scour pad or similar
- Check flange bolts and tower base bolts for tightness
- Listen for any abnormal noises or excessive vibrations, if any exists check for possible loose fittings or components
- Check brake pad thickness is more than 2mm and replace if worn beyond 2mm
- Check brake operation before raising wind turbine
- Check for general wear and tear and replace any worn parts
- Pay particular attention to the blades, especially the blade root and the hinge. A damaged or cracked blade or hinge should be repaired or replaced immediately.



Over filling the bearings will shorten the life of the bearings and result in premature failure.

5.2 Maintenance Check List And Schedule

	Action	Frequency
Tower and base		
General condition	CH	IN/QR/AN
Foundations	CH	AN
Nut and bolt tightness	CH/AD	IN/QR/AN
Shims (where applicable)	CH/AD	AN
Welds and fillets	CH	AN
Hinge bolts	CH	AN
Gin pole assembly	CH	AN
Blades and springs or dampers		
Blade condition	CH/RE	IN/AN
Hinge condition	CH/RE	IN/AN
Blade fixings	CH	AN
Spring or damper fixings	CH	AN
Springs or dampers	CH/RE	AN
Nut and bolt tightness	CH/AD	AN
Wedges (where applicable)	CH	AN
Washers and clamps	CH	AN
Bearings and yaw rollers		
Yaw bearing	CH/GR	AN
Main shaft bearings	CH/GR	AN
Yaw rollers and bolts	CH/GR/RE	AN
Slip ring assembly		
Slip ring connections	CH	AN
Slip ring body	CH/CL	AN
Slip ring brushes	CH/CL/AD/RE	AN
Top hat	CH	AN
Nut and bolt tightness	CH/AD	AN
Brake system		
Brake assembly parts	CH	AN
Brake operation	CH	IN/AN
Brake pads	CH/RE	AN
Shackles	CH	AN
Brake cable	CH/RE	AN
Brake levers	CH	AN
Electrical system		
Condition of wiring	CH	IN/AN
Ph-ph voltage	CH	IN/AN
Controller operation	CH	AN
V and I meters	CH	AN
Cable connections	CH/AD	AN
Inverter operation	CH	AN
Covers		
Generator cover	CH	AN
Yaw cover	CH	AN
Nacelle cover	CH	AN
Cable ties	CH/RE	AN
General		
Check for smooth running	CH	IN/QR/AN
Listen for any abnormal noise	CH	IN/QR/AN
General visual system check	CH	IN/QR/AN

CH - Check
CL - Clean IN - Initial 3 month check
GR - Grease QR - Quarterly
RE - Replace (if need be)
AN - Annually
AD - Adjust (if need be)

TOOLS AND EQUIPMENT	CHECK
Large socket set with extension handle	
Sledge hammer	
Trestle	
Fixings, screws and rawplugs	
Battery drill	
Small and large crimping tools	
Selection of crimps	
Snips	
Wire strippers	
Pliers	
Knife	
Threadlocking compound (Loctite 577 or equal)	
Shifting spanners	
Ratchet and socket	
Spanners (all sizes)	
Screwdrivers	
Allen keys (all sizes)	
Torque wrench	
Cable ties and clips	

TOOLS AND EQUIPMENT	CHECK
Silicone sealant	
Sealant gun	
Electrical test meter	
Safety glasses	
Gloves	
Insulation tape	
Fuses and relays	
Tower door key	
Spare hinge bolts and nuts	
Spare nuts, bolts and washers	
Scotch-Brite HD scour pad or similar	
Grease gun with Lithium EP2 or similar multi-use grease	
Gin poles with fixings	
12t hydraulic jack	
3.2t hydraulic tirfor winch	
30m tirfor rope, 16mm diameter	
3t pulley block	
3t shackle	
3t shackle or short strop	

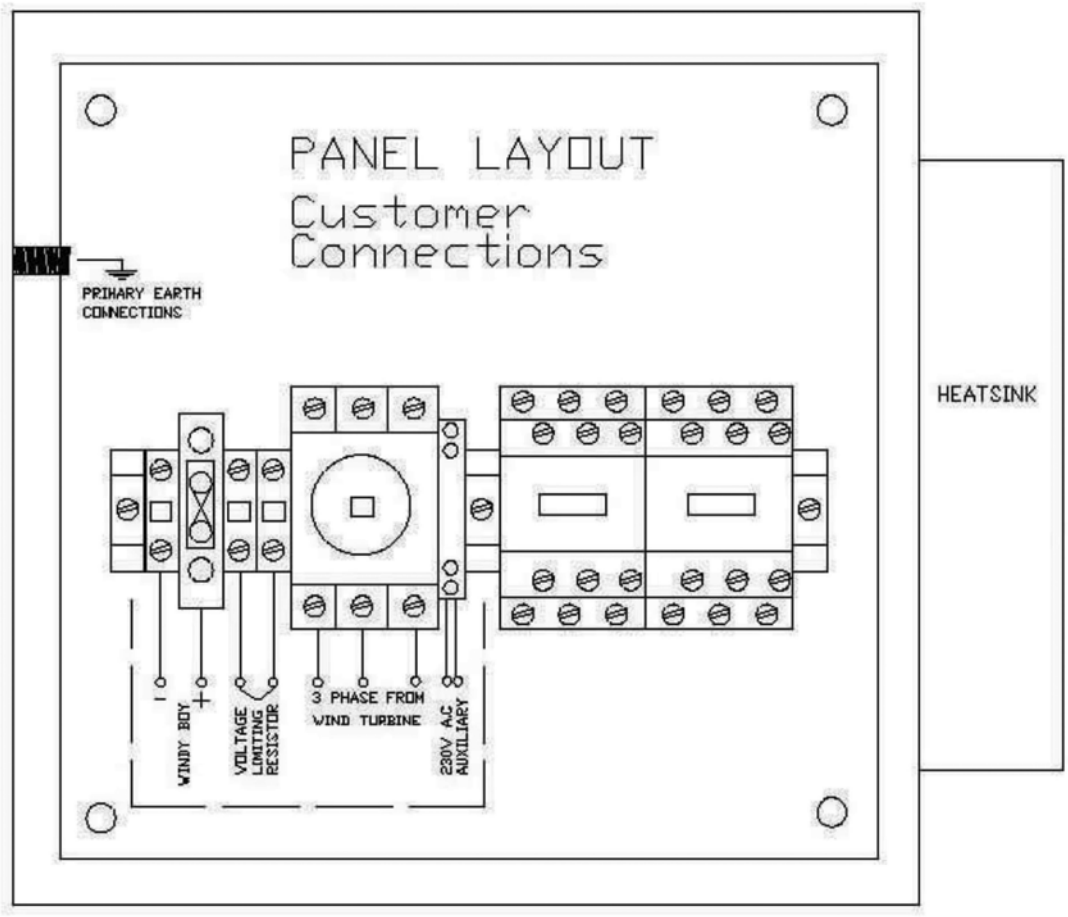
6.0 Trouble Shooting

Problem	Possible Cause	Diagnosis	Remedy
Louder than quoted noise level	Loose fittings or components Damaged blade(s)	Check if all fittings and components are tightly fitted Check blades	Tighten loose fittings or components Fix or replace blade(s)
Wind turbine fails to turn in good wind	Shorted cables Failed bearings Foreign object in generator	Check connections Check bearings Check generator	Repair short circuit Replace bearings Remove obstruction
Wind turbine turns slowly in good wind	Partial short in cables	Check connections	Repair short circuit
Low output	Low wind speeds Obstructions around wind turbine High power usage	Measure wind speed Check siting of wind turbine Check power usage	Site wind turbine in a better location or height Economise power usage
Wind turbine vibrates excessively	Blades incorrectly fitted or out of balance Yaw bearing or yaw rollers worn	Check blades and fittings Check yaw bearing and yaw rollers	Fit blades correctly or replace with a balanced set Replace yaw bearing or yaw rollers
No output though wind turbine turns in high speed	Cables disconnected Controller ammeter open circuit Loss of mains	Check connections Check ammeter Check mains grid condition	Fix cables Replace ammeter Await for restored grid power

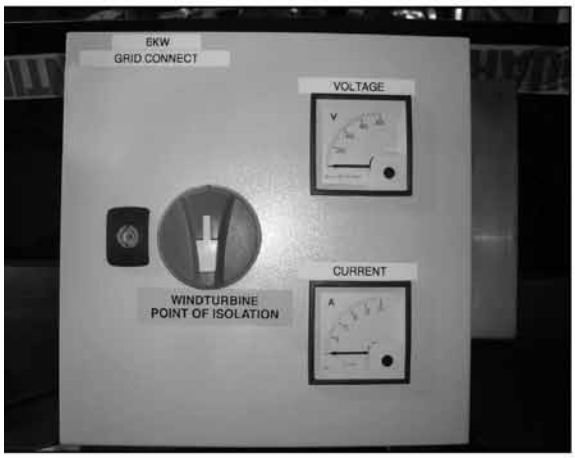
7.0 Appendices

Appendix A: Electrical Schematic Drawings

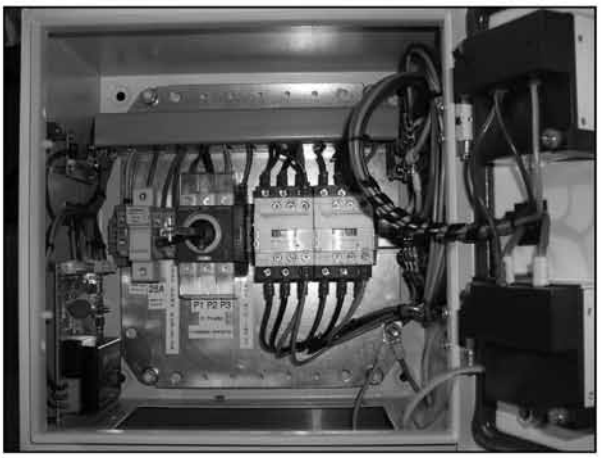
Controller Box Internal Layout



Controller Box - External View



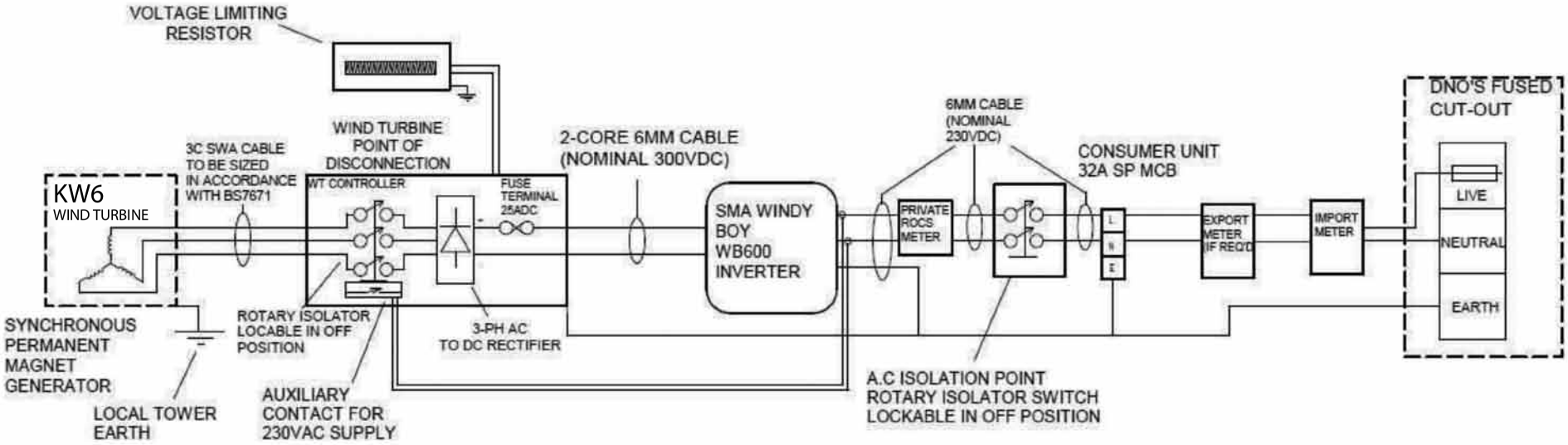
Controller Box - Internal View



Caution

The 3kW/10Ω voltage limiting resistor will become extremely hot during operation and should be mounted indoors in a safe and well ventilated area.

Schematic for TN-S Earthing System (Cable Sheath) using KW6



NOTES

1) WIND TURBINE OUTPUT IS NOMINAL 250VAC 3PH UNDER NORMAL OPERATING CONDITIONS 20HZ BUT VOLTAGE, CURRENT AND FREQUENCY PROPORTIONAL TO RPM/WIND SPEED.
OPEN CIRCUIT VOLTAGE APPROX2 X NORMAL OPERATION. MAX OUTPUT 6kW AT APPROX 200RPM.

2) SMA WINDY BOY WB6000 INVERTER IS EA APPROVED FOR CONNECTION TO UK GRID.

IT INCLUDES

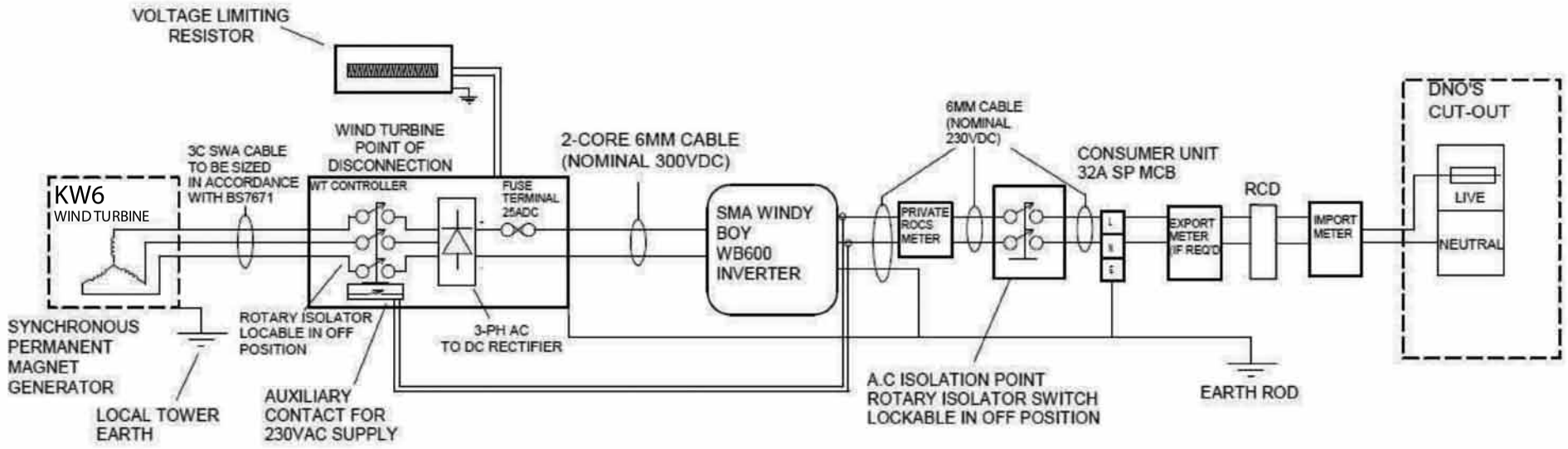
A) OVER/UNDER VOLTAGE PROTECTION
B) OVER/UNDER FREQUENCY PROTECTION
C) LOSS OF MAINS PROTECTION (BY MEANS OF FREQUENCY DRIFT)
D) 180s DELAY FROM RETURN OF MAINS AFTER FAULT TO START OF SELF INITIALISE PROCEDURE.

3) VOLTAGE LIMITING RESISTOR IS RATED 3kW, 10OHM AND SHOULD BE MOUNTED IN A SAFE WELL VENTILATED AREA.

4) A 230VAC SUPPLY IS REQUIRED FOR THE AUXILLARY CONTACT ON THE WIND TURBINE ISOLATOR IN THE CONTROLLER TO OPERATE THE OVER VOLTAGE PROTECTION CIRCUIT.

5) IT IS ADVISABLE THE CONTROLLER, WINDYBOY INVERTER, kWh METER AND LOCKABLE ISOLATOR BE INSTALLED IN CLOSE PROXIMITY TO THE D.N.O CUT-OUT.

Schematic for TT Earthing System (RCD) using KW6



NOTES

1) WIND TURBINE OUTPUT IS NOMINAL 250VAC 3PH UNDER NORMAL OPERATING CONDITIONS 20HZ BUT VOLTAGE, CURRENT AND FREQUENCY PROPORTIONAL TO RPM/WIND SPEED.
OPEN CIRCUIT VOLTAGE APPROX2 X NORMAL OPERATION. MAX OUTPUT 6kW AT APPROX 200RPM.

2) SMA WINDY BOY WB6000 INVERTER IS EA APPROVED FOR CONNECTION TO UK GRID.

IT INCLUDES

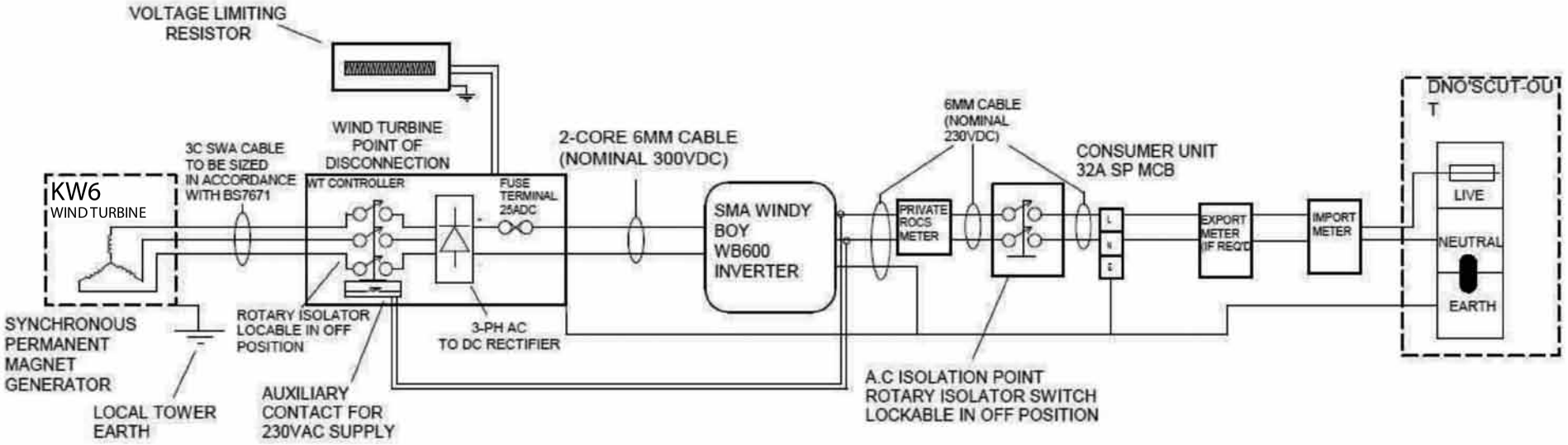
A) OVER/UNDER VOLTAGE PROTECTION
B) OVER/UNDER FREQUENCY PROTECTION
C) LOSS OF MAINS PROTECTION (BY MEANS OF FREQUENCY DRIFT)
D) 180s DELAY FROM RETURN OF MAINS AFTER FAULT TO START OF SELF INITIALISE PROCEDURE.

3) VOLTAGE LIMITING RESISTOR IS RATED 3kW, 10OHM AND SHOULD BE MOUNTED IN A SAFE WELL VENTILATED AREA.

4) A 230VAC SUPPLY IS REQUIRED FOR THE AUXILLARY CONTACT ON THE WIND TURBINE ISOLATOR IN THE CONTROLLER TO OPERATE THE OVER VOLTAGE PROTECTION CIRCUIT.

5) IT IS ADVISABLE THE CONTROLLER, WINDYBOY INVERTER, kWh METER AND LOCKABLE ISOLATOR BE INSTALLED IN CLOSE PROXIMITY TO THE D.N.O CUT-OUT.

Schematic for TN-C-S Earthing System (PME) using KW6



NOTES

1) WIND TURBINE OUTPUT IS NOMINAL 250VAC 3PH UNDER NORMAL OPERATING CONDITIONS 20HZ BUT VOLTAGE, CURRENT AND FREQUENCY PROPORTIONAL TO RPM/WIND SPEED.
OPEN CIRCUIT VOLTAGE APPROX2 X NORMAL OPERATION. MAX OUTPUT 6kW AT APPROX 200RPM.

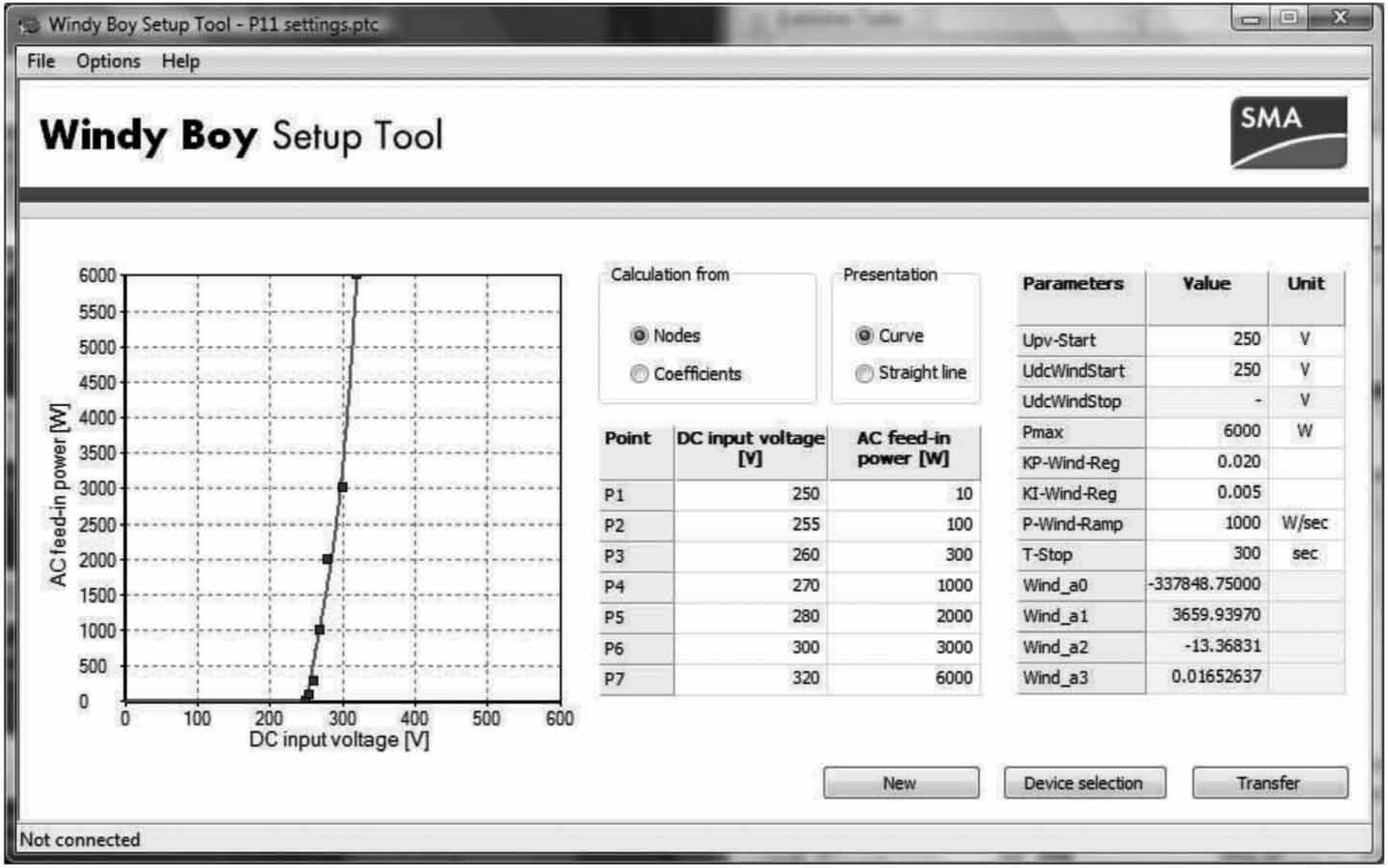
2) SMA WINDY BOY WB6000 INVERTER IS EA APPROVED FOR CONNECTION TO UK GRID.

IT INCLUDES
- A) OVER/UNDER VOLTAGE PROTECTION
- B) OVER/UNDER FREQUENCY PROTECTION
- C) LOSS OF MAINS PROTECTION (BY MEANS OF FREQUENCY DRIFT)
- D) 180s DELAY FROM RETURN OF MAINS AFTER FAULT TO START OF SELF INITIALISE PROCEDURE.

3) VOLTAGE LIMITING RESISTOR IS RATED 3kW, 10OHM AND SHOULD BE MOUNTED IN A SAFE WELL VENTILATED AREA.

4) A 230VAC SUPPLY IS REQUIRED FOR THE AUXILLARY CONTACT ON THE WIND TURBINE ISOLATOR IN THE CONTROLLER TO OPERATE THE OVER VOLTAGE PROTECTION CIRCUIT.

5) IT IS ADVISABLE THE CONTROLLER, WINDYBOY INVERTER, kWh METER AND LOCKABLE ISOLATOR BE INSTALLED IN CLOSE PROXIMITY TO THE D.N.O CUT-OUT.


Windy Boy Setup Tool - P11 settings.ptc
File Options Help
Windy Boy Setup Tool
SMA
AC feed-in power [W]
DC input voltage [V]
Calculation from
Nodes
Coefficients
Presentation
Curve
Straight line
Point
DC input voltage [V]
AC feed-in power [W]
P1 250 10
P2 255 100
P3 260 300
P4 270 1000
P5 280 2000
P6 300 3000
P7 320 6000
Parameters
Value
Unit
Upv-Start 250 V
UdcWindStart 250 V
UdcWindStop - V
Pmax 6000 W
KP-Wind-Reg 0.020
KI-Wind-Reg 0.005
P-Wind-Ramp 1000 W/sec
T-Stop 300 sec
Wind_a0 -337848.75000
Wind_a1 3659.93970
Wind_a2 -13.36831
Wind_a3 0.01652637
New
Device selection
Transfer
Not connected

Appendix B: Delivery, Storage and Handling of Kingspan Wind Turbines

Delivery, Storage and Handling of Kingspan Wind Turbines on Site

Delivery

Before delivery, Kingspan wind turbine and its various components should be protected to ensure the components remain in good condition until they are ready for installation. All materials for delivery should be verified against the delivery document. All required accessories should be delivered together with the main components (excluding the foundation kit which should be delivered prior to the wind turbine shipment).

Materials could be packed in either wood pallets or wood/carton boxes. Upon delivery on site, the materials should be checked for damages during transportation and that the delivered materials are in compliance with the specifications. Any damaged or incorrect materials should be immediately reported to Kingspan reseller or Kingspan depending on where the delivery originated.

Storage

Delivery of materials should be carefully planned according to the installation schedule as to minimise the storage time on site where the possibility of damages is higher. Proper site storage is important in preventing damages to the Kingspan wind turbine and it's components.

A suitable storage location should be:

- sheltered from weathering and fallen objects; and
- located for ease of material handling and movement.

Components should be placed so that there is no direct contact with the ground. In addition, the various components should be arranged according to the installation sequence to facilitate ease of retrieval, i.e. to minimise searching and unnecessary shifting of materials which may lead to damages.

Handling

All handling should be performed in accordance with the Kingspan wind turbine installation manual using only approved lifting equipment and slings suitable for the load. Exceptional care should be given to the blades – especially the leading and trailing edges of the airfoil. Even minor dents can cause a noise issue when the wind turbine is operational.

Kingspan Renewables Limited
180 Gilford Road, Portadown, Northern Ireland,
BT63 5LF, United Kingdom
Tel: 0800 328 5689 E-mail: wind@kingspan-renewables.com
wind.kingspan.com

Due to our continuing policy of development and improvement we reserve the right to alter and amend the specification as shown in this literature.